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Byteflight Safety Systems

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Byteflight Safety Systems

Model: E65/E66 from SOP, E85 from SOP
E60, E63 and E64 from SOP

Production: All with *byteflight*

OBJECTIVES

After completion of this module you will be able to:

- Identify ***byteflight*** related passive safety systems
- Understand the function and operation of passive safety systems with ***byteflight***
- Diagnose ***byteflight*** based passive safety systems
- Perform service related functions on ASE and ISIS systems

Byteflight Safety Systems

Since the launch of the E65, many new innovations to passive safety systems have been introduced to the BMW model line. Other than MRS systems, there are 2 new passive safety systems which utilize the new ***byteflight*** fiber optic technology.

These new systems are:

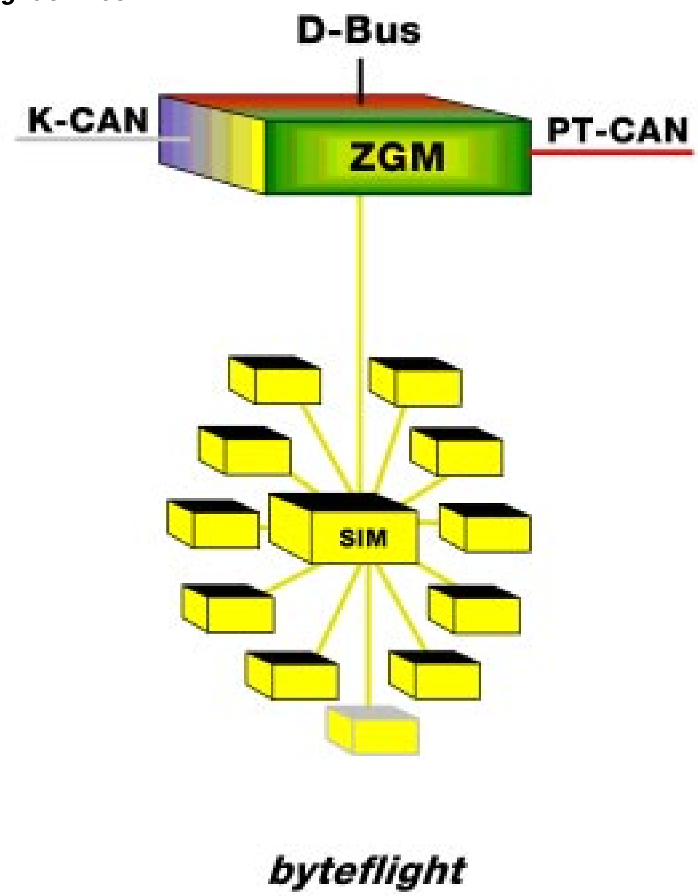
- Intelligent Safety Integration System (ISIS) - used on the E65 and E66
- Advanced Safety Electronics (ASE) - used on the E85, E60, E63 and E64

The above systems, which differ from MRS, use the new ***byteflight*** fiber optic technology. In contrast to MRS, which uses a centrally located control module, the ISIS and ASE systems use ***byteflight*** to allow “decentralization” of the system electronics.

These new systems use remotely located “satellites” to acquire crash data as well as to trigger system components. By moving these satellites closer to potential impact points, the system reaction time is shortened during a collision.

The ***byteflight*** fiber optic network allows for the sharing of crash data between system components. Fiber optics also improve reliability and increase system communication speed.

ISIS System with *byteflight* on E65



ISIS System Structure

The ***byteflight*** fiber optic network utilizes a “star” structure. This arrangement consists of a centrally located module (SIM) with satellites arranged in a radial pattern. Each of the satellites can communicate with the SIM individually.

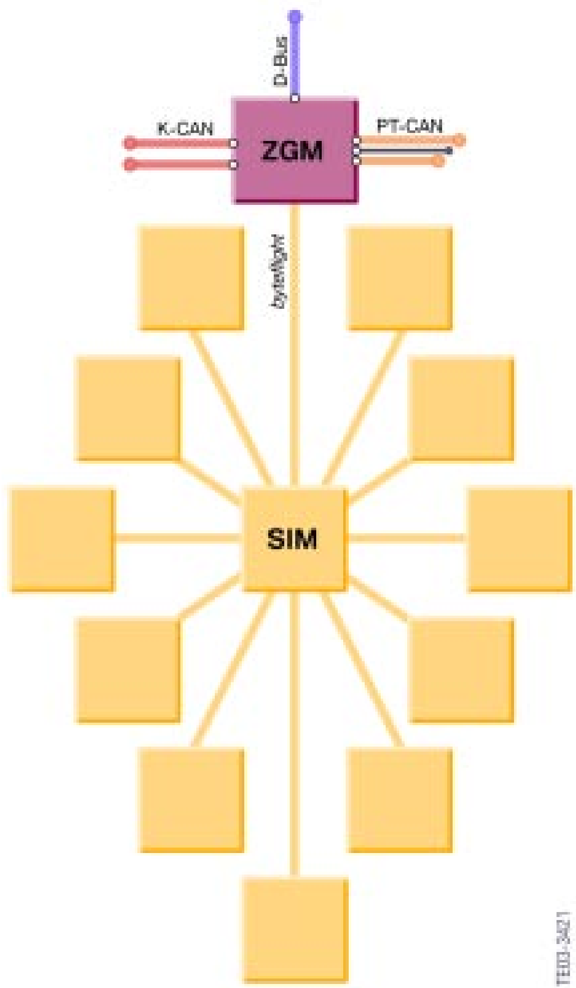
The Safety and Information Module (SIM) contains transmitter/receiver modules (S/E module) for each satellite. Each satellite also contains a transmitter/receiver module.

The SIM is also connected via ***byteflight*** to the ZGM which acts as a gateway between the K-CAN, PT-CAN and the D-bus.

This structure allows the following design objectives to be achieved:

- Earlier and more precise impact detection
- Improved occupant protection
- High transmission speed
- Improved system reliability
- Faster trigger decisions
- Redundant sensor information
- Software update via bus
- No Electromagnetic interference
- Mechanical safety switch no longer needed
- No electrical connection between transmitter and receiver module
- Optical fibers are lighter than copper wires
- System can be updated/retrofitted easily

Example of Star Structure on the ISIS system



On the ISIS system, the acceleration sensors are integrated into the satellites. The airbag ignition circuits for the relevant airbag are also contained within the satellite. Each satellite is installed in various strategic locations throughout the vehicle. This method allows for de-centralization of the system electronics which results in earlier crash detection as well as shorter “reaction” times during impact.

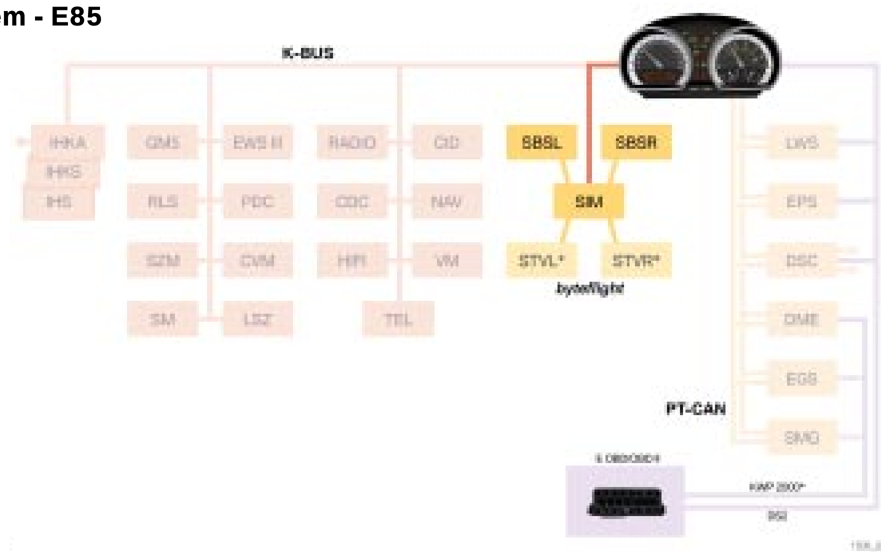
The ASE systems share the same basic structure as the ISIS system, but there are less satellites within the system.

ASE System Structure

The ASE system was first introduced with the E85 and then later adapted to the E60, E63 and E64.

The E85 only uses 4 satellites connected to the SIM. The E85 does not use a separate ZGM, but the SIM carries out some of the ZGM functions. The "ZGM" function of the SIM acts as a gateway between the ***byteflight*** and K-Bus. And the instrument cluster (kombi) is used as a gateway to the PT-CAN, K-Bus and D-bus.

ASE System - E85

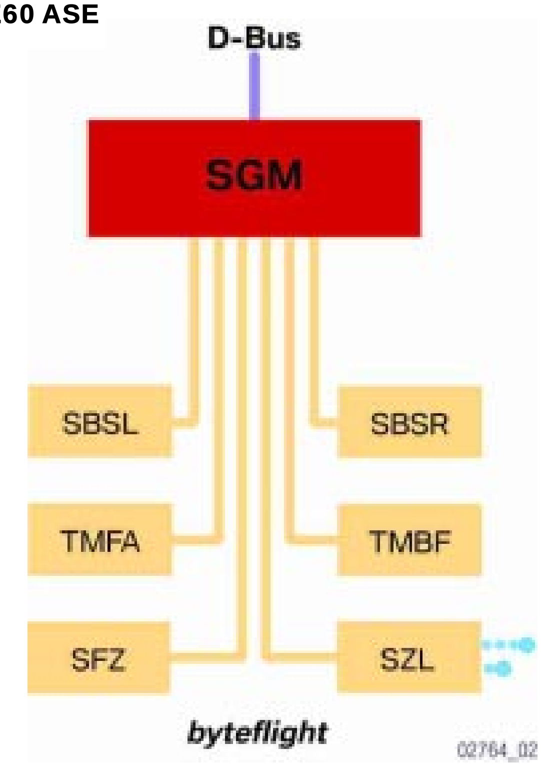


In comparison to the E85, the E60 has more systems which requires the use of additional satellites. There are 6 satellites used which are connected to the SGM (Safety and Gateway Module).

The SGM combines the functions of the SIM and ZGM used on the E65. It carries out the gateway function between ***byte-flight*** and the D-Bus. The SGM also performs some additional functions which will be discussed later in this training module.

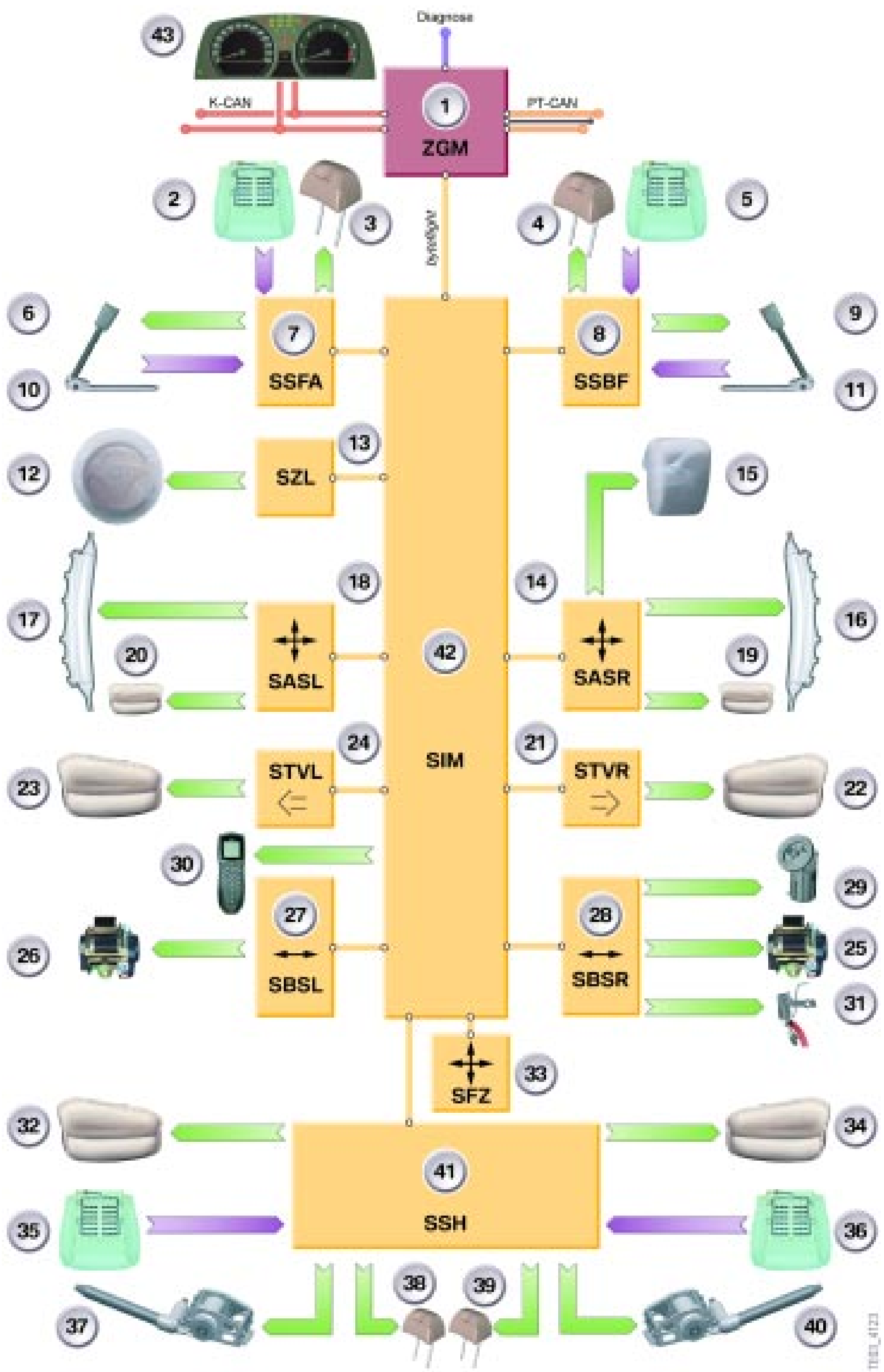
The E63 and E64 use a similar structure and share many of the components from the E60.

E60 ASE



Intelligent Safety and Information System (ISIS)

ISIS Components



Index	Explanation	Index	Explanation
1	Central Gateway Module (ZGM)	23	Side airbag, front left
2	Driver’s seat occupancy detection	24	Door satellite, front left (STVL)
3	Active headrest, driver	25	Belt force limiter, right
4	Active headrest passenger	26	Belt force limiter, left
5	Pass. seat occupancy detection	27	B-pillar satellite, left (SBSL)
6	Seatbelt tensioner, left	28	B-pillar satellite, right (SBSR)
7	Driver’s seat satellite (SSFA)	29	Electric fuel pump
8	Passenger seat satellite (SSBF)	30	Telephone/TCU
9	Seatbelt tensioner, right	31	Safety battery terminal (BST)
10	Seatbelt buckle switch, left	32	Side airbag, rear left
11	Seatbelt buckle switch, right	33	Vehicle center satellite (SFZ)
12	Front airbag, driver	34	Side airbag, rear right
13	Steering column switch cluster (SZL)	35	Seat occupancy detection, rear left
14	A-Pillar Satellite, Right (SASR)	36	Seat occupancy detection, rear right
15	Front airbag, passenger	37	End fitting tensioner, left
16	AITS 1 or 2 (right)	38	Head restraint adjustment motor, rear left
17	AITS 1 or 2 (left)	39	Head restraint adjustment motor, rear right
18	A-Pillar Satellite, Left (SASL)	40	End fitting tensioner, right
19	Knee airbag, right	41	Rear seat satellite (SSH)
20	Knee airbag, left	42	Safety and Information Module (SIM)
21	Door Satellite, front right	43	Instrument Cluster
22	Side airbag, front right		

Central Gateway Module (ZGM)

The ZGM is located in the electronics carrier behind the glovebox. It carries out the task of a gateway between the following:

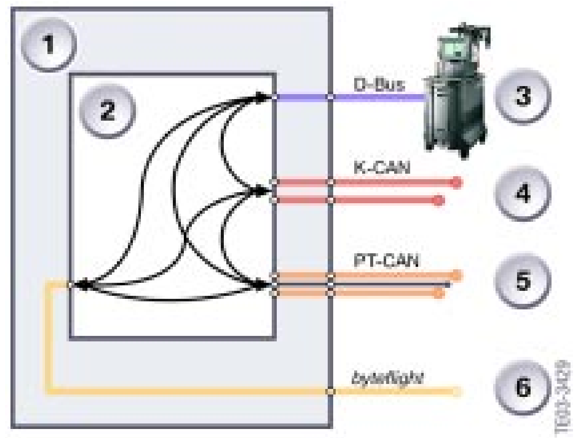
- ***byteflight***
- K-CAN-P
- D-bus
- PT-CAN (and wake-up)

The gateway translates messages between bus systems and controls the flow of data to and from each system. The only connection for the D-bus is at the ZGM. This means that all diagnostic communication must pass through the ZGM.

The ZGM also has the ability to determine if a BMW diagnostic tool is connected or an after-market scan tool. This allows access to only the necessary data needed.

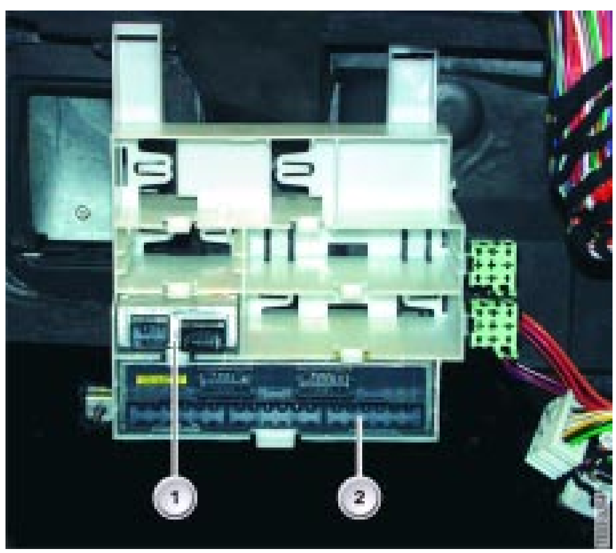
A non-volatile memory is also integrated into the ZGM which can be used to store configu-ration, diagnostic and crash data.

Gateway function of ZGM



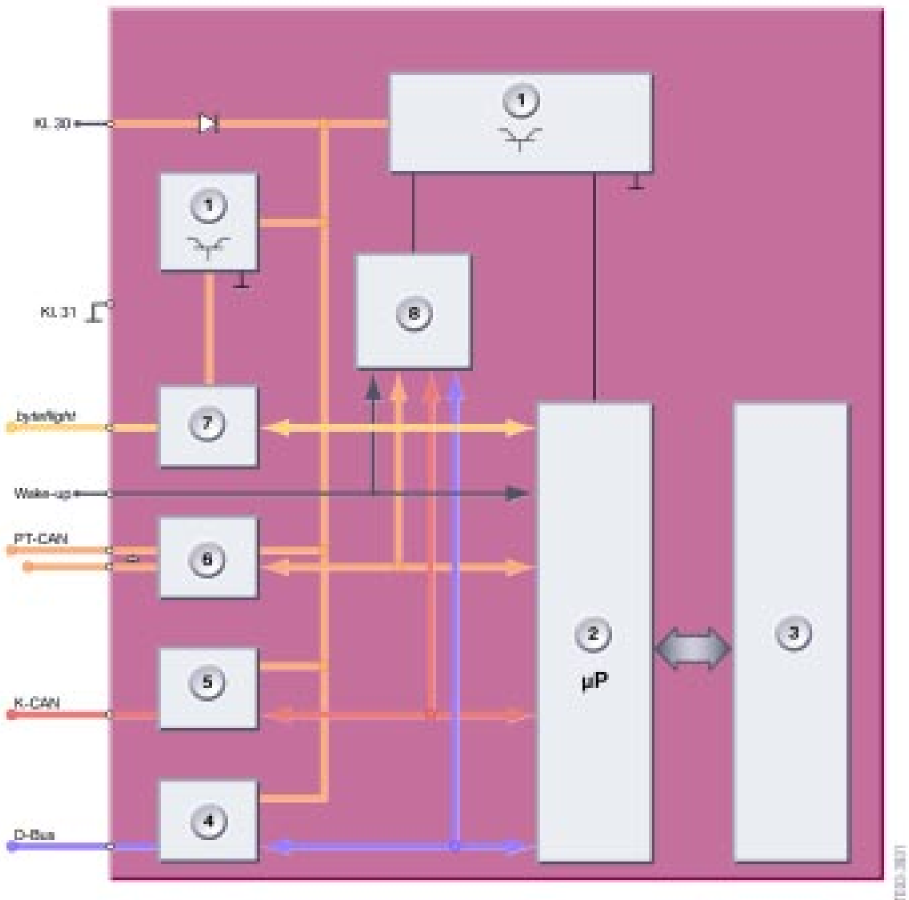
Index	Explanation
1	ZGM
2	Gateway function
3	Diagnosis Bus
4	K-CAN-P
5	PT-CAN with wakeup line
6	***byteflight***

Location of ZGM and SIM
(Behind glove box)



Index	Explanation
1	Central Gateway Module (ZGM)
2	Safety and information module (SIM)

ZGM Schematic



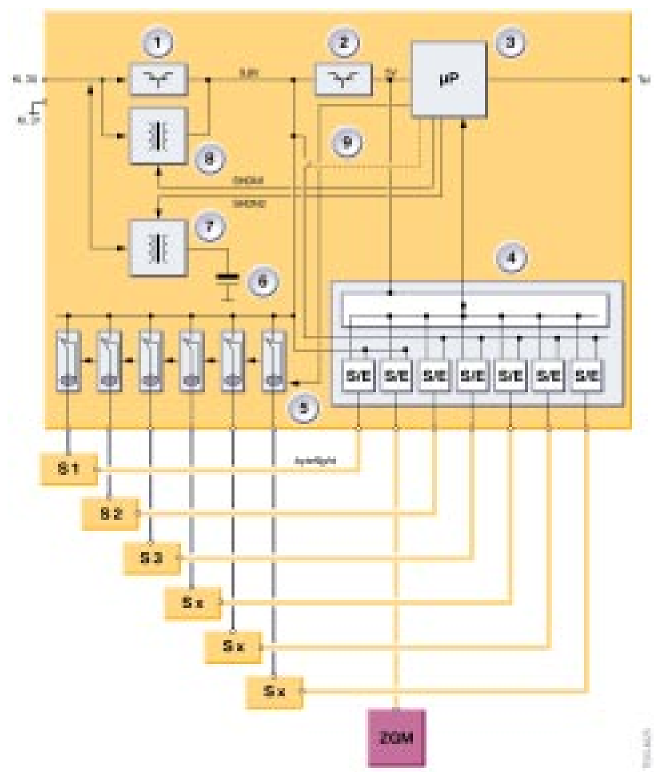
Index	Explanation	Index	Explanation
KL30	Power Supply (constant B+)	2	Microprocessor
KL31	Ground connection	3	Data memory
byteflight	Optical fiber (bus)	4	Driver for D-bus
PT-CAN	Powertrain CAN	5	Driver for K-CAN
K-CAN	Body CAN (P)	6	Driver for PT-CAN
D-Bus	Diagnostic Bus	7	Transmitter/receiver module
1	Voltage regulator	8	Wake-up logic

Safety and Information Module (SIM)

The SIM is located in the electronics carrier behind the glove box and performs 3 main tasks:

- The satellite power supply and reserve, if the power supply should fail during an accident.
- The function of the intelligent star coupler and the main controller for the ***byteflight*** bus.
- Triggering an automatic emergency call by sending a signal to the TCU.

SIM E65/E66



Index	Explanation	Index	Explanation
1	Linear controller	9	Switch
2	Linear Controller	SHDN	Shutdown
3	***byteflight*** master	S/E	Transmitter/Receiver module
4	Star coupler	S1-SX	Satellites
5	Distributor with overcurrent fuses	ZGM	Central Gateway Module
6	Capacitor	TEL	Telephone/TCU
7	Switching controller	KL30	Terminal 30
8	Switching controller	KL31	Terminal 31

Power supply to the operational safety systems
The SIM is supplied with voltage via terminal 30 and 31. If the on-board supply voltage is sufficiently high, power is fed to switching controller (8) which routes voltage to the S/E module (4) and switching controller (5).

The second switching controller (7) is supplied via KL30 and controlled by the microprocessor via the SHDN 2 line. The capacitor is charged from KLR. The capacitor charge forms the power reserve. The charge voltage is 400 V.

Power Supply in the event of an impact
If the on-board voltage supply falls below approximately 8V, switching controller (7) is immediately operated in the opposite direction. The switching controller generates the voltage which replaces the supply from KL30 until the capacitor is empty or the on-board voltage supply is restored. The switching controller is controlled by the microprocessor via the SHDN2 line. At terminal R, the switching controller is switched off again. However, there is no defined discharging of the capacitor.

Consumer Shutdown
Switching controller (8), which supplies the voltage to the S/E module and the satellites via switching controller (5), is switched to sleep mode by microprocessor (3) via the SHDN1 signal (shutdown) due to the off-load current. To ensure that the necessary main functions also continue in sleep mode, a 9.8 V linear controller (1), which is in constant operation, is switched in parallel with the switching controller. This voltage supplies the wakeable S/E modules and a downstream 5V linear controller (2). This second linear controller supplies the microprocessor. The wakeable S/E modules are connected to the satellites (SZL,ZGM), which can wake up the ***byteflight.*** The other S/E modules are supplied by the switching controller (8) via switch (9) and are switched off in sleep mode.

Type of Voltage	Voltage	Function
Voltage supply	9-16 V	Full function
	8-9 V	Full function, except turning on switching controllers
	< 8 V	Full function from the power reserve for approximately 3 seconds if the voltage was previously greater than 9 volts for at least 4 seconds
	16-25 V	Limited function, no destruction, no undefined behavior
Output voltage at the SIM	minimum 9.4 V	All power distribution outputs to the connected satellites carry approximately 80 mA (SZL 120mA)
	maximum 9.9 V	Distributors carry no load, SIM runs internally
Power Intake	< 1 mA	In sleep mode
	typ. 1.2 A	Max 4 A short term in normal operating mode
	typ. 4A max 6A	After the wake up for 4 seconds while the power reserve is being charged

Intelligent Distributor

The intelligent distributor is a system which performs the following tasks:

- Power supply for each individual satellite
- Current limitation for each individual satellite
- Power shutoff for each individual satellite if a fault occurs

The SIM supplies all of the satellites centrally in order to ensure that the safety system functions reliably. The power must be distributed intelligently so that the system can continue to function smoothly if there is a short circuit or overcurrent on one of the supply lines.

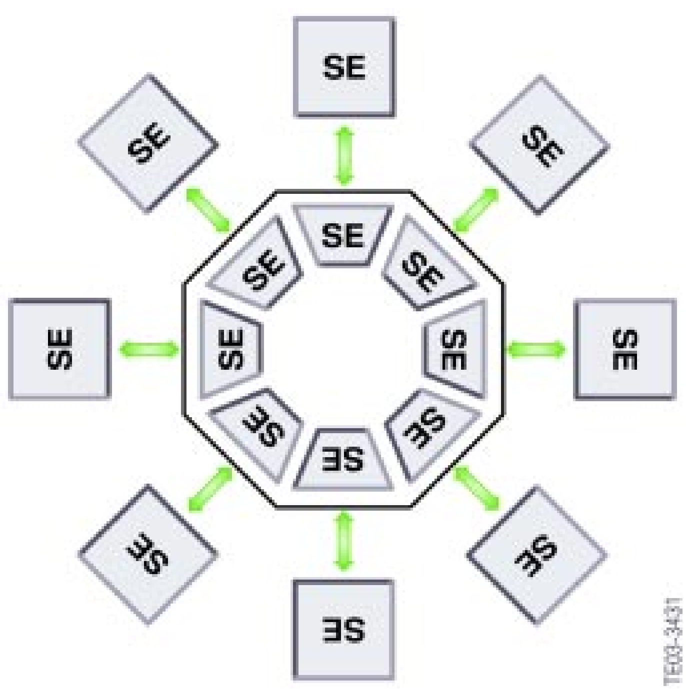
The distributor integrated into the SIM limits the current to the satellites to 100 mA on each line. An exception is the satellite for the steering column switch cluster, for which the current intake is approximately 120 mA, because the steering wheel module must also be supplied. If the current limit is exceeded the power supply is cut.

It is also possible for the microprocessor to shut off each individual distributor output and therefore each individual satellite.

Intelligent Star Coupler

The transmitter and receiver module is a component which can convert electrical signals into optical signals and transmit them via fiber optic cables. Each satellite has an S/E module.

The S/E modules are each connected to the star coupler in the SIM via the ***byteflight*** bus. There is also an S/E module for each satellite in the SIM.



All of the information transmitted via the ***byteflight*** bus takes the form of messages which are sent as pulses of light. The S/E modules in the SIM receive the light pulses from the satellites that are connected to them. In the intelligent star coupler, the messages are forwarded to all of the satellites. Data exchange is possible in both directions.

The S/E modules consist of a light emitting diode (LED) and a photo diode, which are mounted one on top of the other using chip-on-chip technology. This means that both components are connected to the fiber optic cable in the optimum way.

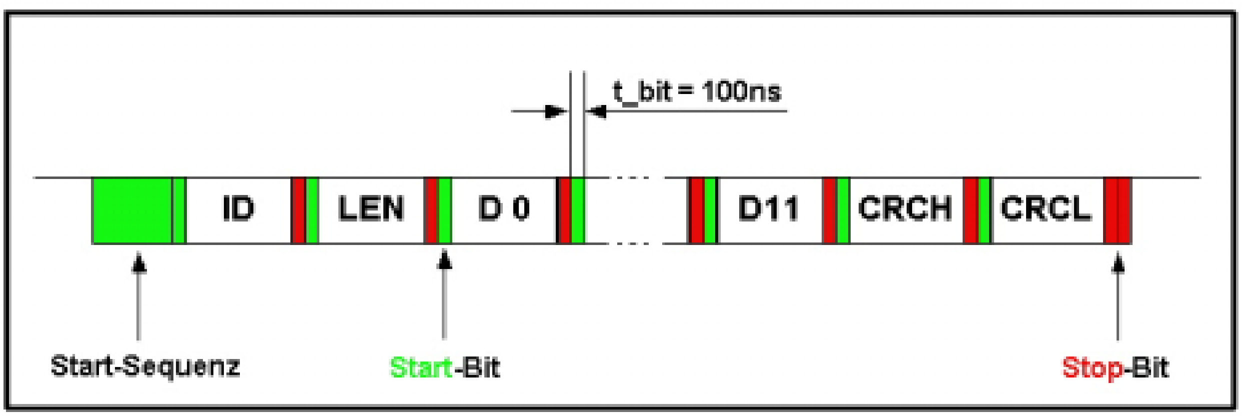
The transmitter and receiver module contains the LED for the driver switching and the receive amplifier for the converting the optical signals into digital signals. Monitoring of the optical transfer quality is also integrated.

The satellite is switched off if one of the following faults occurs on one of the fiber optic cables:

- No optical signal received in a defined period of time
- A transmitting diode is sending continuous light
- Attenuation is too high

Message

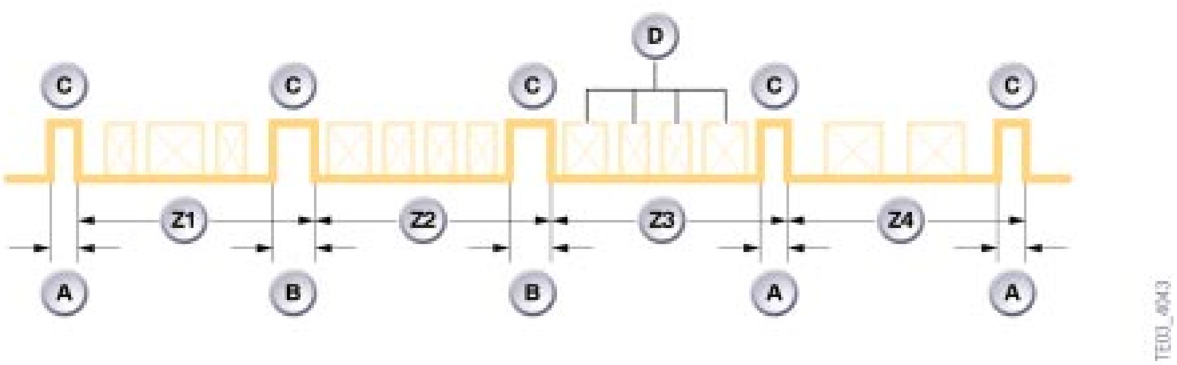
A data message consists of blocks of data known as bits and bytes. The basic structure of a message is shown in the following diagram:



A message always starts with a start sequence, followed by an identifier byte which determines the priority of the message. There is a start bit before every byte and a stop bit after every byte. The next byte is the length of the byte, which gives the number of data bytes. This is followed by a maximum of 12 data bytes and then the checksum. A double stop bit indicates the end of the message. Each device attached to the bus can send messages via the ***byteflight*** between synchronization pulses.

Synchronization Pulses

The ***byteflight*** main controller in the SIM emits synchronization pulses every 250ms. Alarm mode is triggered by the length of the synchronization pulse. The length of a synchronization pulse in alarm status is approximately 2ms. In normal mode, the synchronization pulse is approximately 3ms.

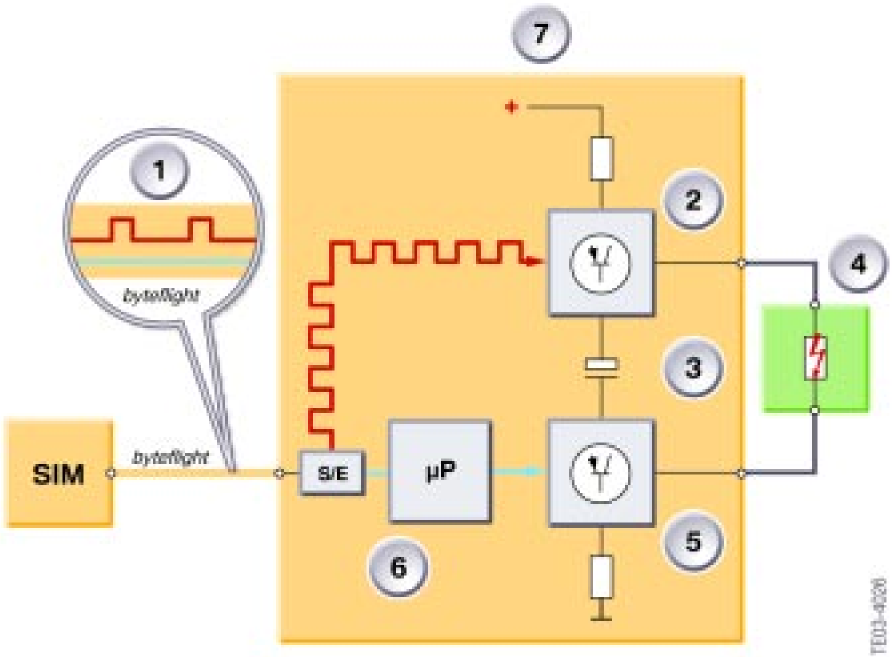


Index	Explanation
A	Alarm synchronization pulse
B	Normal synchronization pulse
C	Synchronization pulse
D	Message
Z1-n	Cycles

The bus main controller must decide when to put the satellites in alarm mode using the available sensor information. When the bus main controller sets alarm mode, all ignition power circuits for the safety system are primed.

Two separate signals must be transmitted via the ***byteflight*** in order to trigger the ignition output stage. The ignition power circuit high-side switch is controlled by the ***byteflight*** alarm mode. The low-side switch is controlled by the microprocessor in the satellites. The triggering algorithm detects when the low-side switch must be closed using the transmitted message and sensor signals.

The following diagram shows an example of an ignition output stage for triggering the required signal paths:



Index	Explanation	Index	Explanation
1	Alarm mode pulse	6	Microprocessor
2	High-side switch	7	Satellite
3	Ignition capacitor	S/E	Transmitter/receiver module
4	Igniter pellet	SIM	Safety and Information module
5	Low-side switch		

Software Reset

The SIM can cut the power supply to individual satellites using the intelligent distributor. This function is used to perform a software reset. The relevant status message is used to monitor the satellites. The satellite is switched off if one of the following faults is detected by the bus main controller:

- Internal fault in the satellite
- Incorrect system time
- Status message not received

Depending on the type of fault, the module will try to switch the satellite back on twice after 100 ms. If the fault is not rectified by the power-ON reset which has been triggered in the satellite module, the satellite remains switched off until the next wake-up in the bus system.

System Time
The system time is used as a reference when storing events, such as faults or the ignition of pyrotechnic actuators. This allows the events saved in different control units to be classified according to time.

In the ISIS, the SIM is the bus main controller and therefore responsible for generating synchronization pulses. The SIM is therefore logically also the reference for system time.

There is a common system time for all equipment attached to the bus in the ISIS. The system time is started by a diagnostic command when the vehicle is manufactured. This process can only be carried out once, it is not possible to reset the system time.

The time resolution is 250 ms and is triggered by the synchronization pulses on the ***byteflight.*** This means that only actual operating time is recorded while the ***byteflight*** is active. The maximum time is more than 76,000 hours.

The time is stored in the microprocessor RAM. An entry is also made in the EEPROM under the following circumstances:

- Once an Hour
- Upon entering sleep mode
- When the battery is disconnected
- When the entire system is powered by the power reserve

Synchronization of the system time
To ensure that the system time is the same in all modules, it is essential that all of the equipment attached to the bus is synchronized regularly. A distinction must be made between synchronization in normal operating mode and the synchronization of additional modules which are installed in the system as new components.

Synchronization in normal operating mode
A system time message is sent by the SIM when the ***byteflight*** is restarted after sleep mode and approximately every 16 seconds during operation.

Because the message has a relatively low priority, it may not be transmitted immediately. This causes an asynchronous time value between the SIM and the satellites. As the SIM knows the time at which the message was sent, it is possible to correct this.

A second system time message is sent containing the correction value.

The correct system time is the sum of the values contained in the two system time messages. The control units (satellites) do not accept the system time until both system time messages have been received.

Synchronization of new modules

New satellite modules that are installed do not have any system time. The system time is transferred to the module by sending the two system time messages.

This is only possible if the system time stored in the satellite modules is less than the sent time. If the system time is a module is greater than the sent time (i.e. if the module has been transferred from another vehicle), the system time is not accepted and an entry is made in the fault memory.

If the SIM is replaced, the system time must be re-entered. Because the system time is present on all satellite modules, it must be transferred from there to the SIM. This can be done using the diagnostic interface (DISplus/GT-1).

The diagnostic calculator calls up the system time from all of the satellites and selects the largest. The diagnostic calculator adds an amount and transfers the result to the SIM as a system time.

The correction amount compensates for the delay between when the system time is read from the satellites and when it is entered on the SIM. This avoids error messages being generated by the satellites because the system time transferred by the SIM is smaller than that stored on the satellite.

Also, when the system time is set, the VIN (chassis #) and the mileage are also transferred to the new satellite as well. Failure to set system time will also result in the inability to code the new satellite.

Self Diagnosis of the ISIS

Self-diagnosis of the entire ISIS consists of several parts:

- Self-diagnosis of the SIM
- Pre-drive check, phase 1
- Pre-drive check, phase 2
- Self-diagnosis in operation

Self Diagnosis of the SIM

When KLR is switched on, or on wake-up, an internal self-diagnosis of the SIM is carried out first. The following components are tested:

- Test of the analog/digital converter
- Flash test
- RAM test
- EEPROM test
- Test of the watchdog reset

If a fault occurs during one of these tests, it is recorded in the fault memory. This stops, the program and no communication is possible via the bus. As the instrument cluster is no longer receiving any signals, the airbag warning light (AWL) lights up.

Pre-drive Check

When terminal R is switched on, a self-diagnosis of the overall system, the so-called pre-drive check, is carried out. During this period, the system cannot be triggered. This is indicated by activation of the AWL. The total duration of a fault-free pre-drive check is less than five seconds. The pre-drive check is divided into two phases.

The pre-drive check does not start until the SIM has received the first control unit status report from all modules which it knows from coding and only if no faults have been reported. If it does not receive the status report from a module or if a fault is reported, the power to the satellite module is switched off. Only then is the pre-drive check started.

Pre-drive Check, Phase 1

In phase 1 of the pre-drive check, the ignition output stages which are controlled by the alarm pulse are tested, with the exception of the high-side transistor. No alarm pulse is generated during phase 1. The sensors are stimulated and tested. Once these tests have been carried out, the result is reported in the control unit status message. An OK message is only sent if all tests have run without any faults. If any faults have occurred during the pre-drive check, these are stored in fault memory.

Pre-drive Check, Phase 2

In phase 2 of the pre-drive check, the alarm path from the SIM to the ignition output stages are tested. The SIM sends an alarm pulse, which is returned after a 30ms delay. Each satellite now sends a status report with an OK message to the SIM. If the alarm mode has not been received correctly, a fault is logged in the fault memory. This completes the pre-drive check and the module can now operate in normal mode.

For the control units with ignition output stages in particular, this means that the ignition capacitors can be charged. If all ignition capacitors are fully charged, this is reported to the SIM in the status report. The AWL is switched off when all the modules report full ignition capacitors and no fault is determined.

Self Diagnosis in Operation

During operation, the SIM monitors itself continually as far as possible. The contents of the satellite flash memory are checked using a checksum. If a fault is detected, ***byteflight*** communication is stopped and the power supply from the SIM to the satellites is cut.

The S/E modules allow the optical signal quality to be diagnosed. A warning signal is generated if the optical reception quality does not reach a certain threshold value. If this is the case, communication cannot function without faults. If this warning signal occurs during operation, an entry is logged in the fault memory.

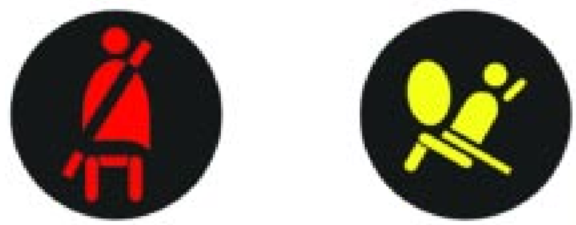
During operation, ***byteflight*** messages are monitored for safety-relevant information. If one of these messages is not received within a set time, an entry is logged in the fault memory.

The SIM and all satellites continually check the vehicle identification numbers received via the ***byteflight*** against the VIN’s entered into the control units. If these do not match or if an entry is missing, the AWL is switched on. This ensures that two control units with potentially incorrect coding data which have been swapped between vehicles do not remain undiscovered.

The mileage reading is also stored in the SIM. To create a link between system time and the mileage reading, the current mileage reading is stored when the system is synchronized.

Airbag warning lamp and check control messages

Various systems can display ISIS faults. These include indicator lamps, graphic symbols (pictograms) and check control messages.



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The indicator lamps include the AWL and the seat belt indicator lamp.

The AWL is activated in the pre-drive check and is switched on if any of the following system faults occur:

- Fault in the self-diagnosis of the SIM
- Fault during pre-drive check
- Communication fault in the ***byteflight***
- VIN number is missing or incorrect

The graphic symbols appear in the information display on the instrument cluster. The following symbols are possible:

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The red airbag symbol is activated if there is a fault in the driver/passenger front airbag. The yellow airbag symbol is activated if there are faults in the side or head airbags or in the belt tensioners or belt force limiters.

The yellow service symbol is activated if there is a fault in the fuel pump.

In addition, fault messages can also be displayed in the Check Control Module.

The faults detected by the satellites in the control unit or the associated peripherals are sent to the SIM as a status report. These messages are transferred from the SIM via the ***byteflight*** to the ZGM and via the K-CAN to the information display.

Activation of the AWL, the graphic symbols and the Check Control messages are controlled by the instrument cluster on the basis of the data received from the SIM.

If the safety-relevant functions in the overall system are operating correctly, the SIM transmits a message to the instrument cluster at regular intervals, approximately every 200ms.

If this signal fails for longer than 2 seconds, the information display indicates this as a fault in the system by illuminating the AWL.

Check Control Messages

ID	Check Control Message	Supplementary note on the Control Display
77	Seat-belt indicator lamp activation	
92	Fault in passenger restraint system	Protection restricted in the event of an accident. Function of belt tensioners and belt force limiters not ensured. Fasten seat belt notwithstanding. Contact BMW service immediately.
93	Driver restraint system fault	Protection restricted in the event of an accident. Function of belt tensioners and belt force limiters not ensured. Fasten seat belt notwithstanding. Contact BMW service immediately.
94	Fault in restraint system, rear left	Protection restricted in the event of an accident. Function of belt tensioners and belt force limiters not ensured. Fasten seat belt notwithstanding. Contact BMW service immediately.
95	Fault in restraint system, rear right	Protection restricted in the event of an accident. Function of belt tensioners and belt force limiters not ensured. Fasten seat belt notwithstanding. Contact BMW service immediately.
97	Fault in safety system	In the event of an accident, the level of protection is severely restricted. Function of airbags, belt tensioners and belt force limiters not ensured. Refer to owner's manual. Contact BMW service immediately.
106	Fault in side airbags, rear left	The function of the side airbag, rear left is not ensured. If possible do NOT occupy the seat. Contact BMW service immediately.
107	Fault in side airbags, rear left	The function of the side airbag, rear right is not ensured. If possible do NOT occupy the seat. Contact BMW service immediately.
108	Driver's front airbag fault	The function of the driver's front airbag, rear left, is not ensured. Contact BMW service immediately.
109	Passenger front airbag fault	The function of the passenger front airbag, rear left, is not ensured. Contact BMW service immediately.
216	Fault in fuel pump	It is possible that the vehicle may breakdown. Contact BMW service immediately.

Fault Memory

The control unit has a fault memory in the EEPROM. The fault memory is divided into a primary fault memory and a shadow memory.

Primary Fault Memory

The primary fault memory stores all safety relevant faults, for example if individual airbag functions have to be deactivated. This is indicated by the AWL or the check control messages.

Shadow Memory

The shadow memory stores faults which were detected but which have no impact on the operational reliability of the system.

Fault Code Memory Entry

Each fault detected during the self-diagnosis is stored here, but each fault code is only stored once. If the same fault code occurs again, the entry is updated. The control unit can store a maximum of 20 different fault codes. Any faults occurring beyond this are not stored and are lost.

If all the possible fault code memory spaces are already occupied, any entries that might be present in the shadow memory are overwritten by new entries of the primary fault code memory.

Erasing the Fault Memory

The fault memory entries can either be completely or individually erased. Erasing separate faults is used for diagnostic purposes. If several faults are stored, an individual fault can be erased to check whether the fault occurs again.

Notes:

A-pillar Satellite (SASL,SASR)

The left and right A-pillar satellite are practically the same. They are installed under the A-pillar trim in the footwell area.

Both SASL and SASR are connected to the SIM via ***byteflight***. The satellite power supply is also from the SIM and is buffered by the capacitor. When the ***byteflight*** is in sleep mode, the satellite power supply is switched off by the SIM. The software reset is also performed by the SIM.

The SASL/R controls and monitors the igniter pellets for the knee airbag and for the AITS 1 for the driver and passenger head protection. If equipped with the optional rear side airbag the AITS is also controlled and monitored by the SASL/R. In addition, the SASR is responsible for the control and monitoring of the front passenger airbag.

Sensors

An acceleration sensor for longitudinal acceleration and one for lateral acceleration is incorporated into the SASL and SASR. The sensors provide a voltage as a measured variable. This voltage is a measurement for the vehicle acceleration. This voltage signal is filtered, magnified, converted and sent as a message.

The strategic positioning of the acceleration sensors in the vehicle allows the direction and accident severity to be detected in the satellites using detected sensor data.

The ISIS detects whether the accident severity and direction of impact is a head-on, side or rear end collision.

The greatest possible protection for the occupants is provided by triggering the relevant pyrotechnic actuators for the accident using the stored algorithm and in conjunction with the seat occupancy recognition and the seat belt use detection.

Ignition power circuit self diagnosis

During the pre-drive check, all of the ignition power circuits are checked. If no faults occur during the check, the ignition capacitors are charged and the satellites are ready for triggering.

The check of the high and low side switches takes place with the ignition capacitor discharged. This prevents any ignition circuit from being triggered accidentally if a fault should occur.

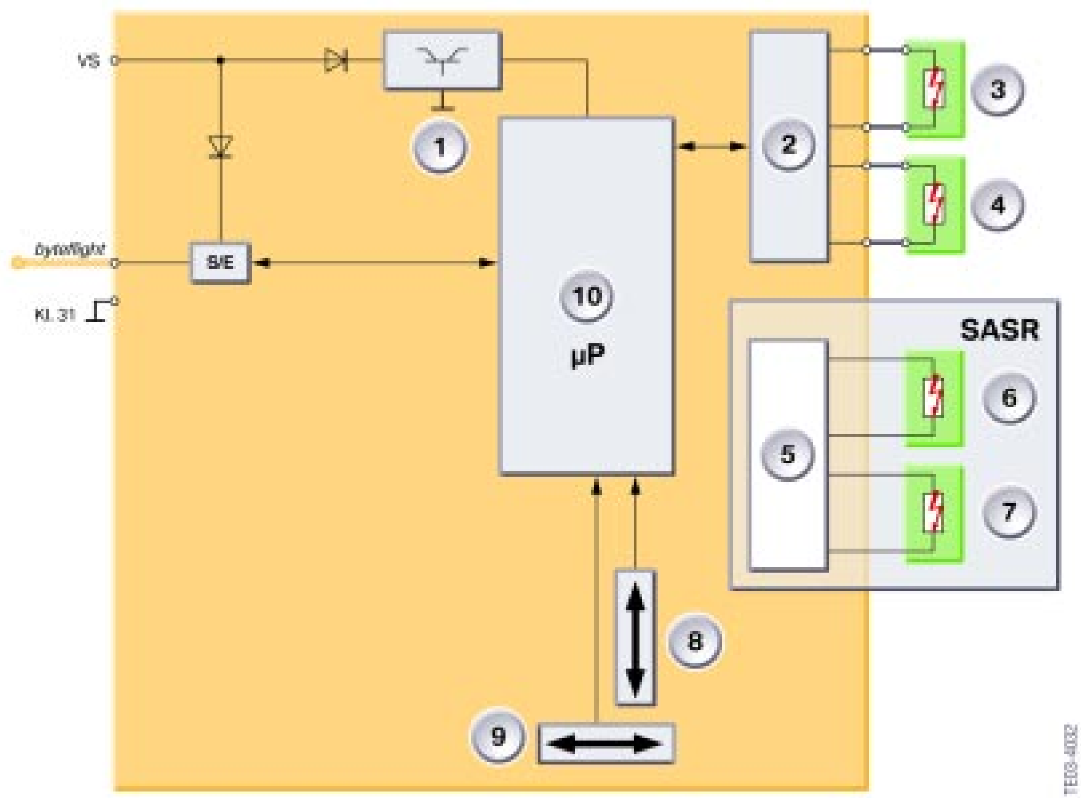
There is no risk of accidental deployment if any other faults should occur. The faults are indicated via the AWL and stored in the fault memory.

Self diagnosis in normal operation

In normal operation, there is a permanent check of the ignition power circuits. A fault message is issued, but only when the fault is confirmed over a specific period of time.
If a short circuit to ground or short to B+ is detected, the corresponding ignition capacitor is discharged.

In normal operation, the self diagnosis is restricted to checking the ignition power circuit for short to ground, short to B+ and for open circuits.

Type of voltage	Voltage	Function
Voltage supply	9.5-11 V	Full Function
	11-16 V	Restricted function, diagnosis of ignition circuit not possible
Power intake	typical 80 mA	In normal operation



Index	Explanation	Index	Explanation
VS	Power supply for satellites from SIM	5	Passenger front airbag ignition output stage
S/E	Transmitter/receiver module	6	Igniter pellet 1st stage for passenger front airbag
SASR	A-pillar satellite, right	7	Igniter pellet 2nd stage for passenger front airbag
1	Voltage regulator	8	Longitudinal acceleration sensor
2	Ignition output stage for AITS1/2 and knee airbag	9	Transverse acceleration sensor
3	AITS1/AITS2 igniter pellet	10	Microprocessor
4	Knee airbag igniter pellet		

Left B-pillar Satellite (SBSL)

The left B-pillar satellite is installed in the B-Pillar above the seat belt inertia reel. The SBSL is connected to the SIM via ***byteflight***. The satellite power supply is also from the SIM and is buffered by the capacitor. When the ***byteflight*** is in sleep mode, the SBSL power supply is switched off by the SIM which also performs the software reset.

The SBSL controls and monitors the igniter pellets for the belt force limiter of the seat belt on the driver's side.

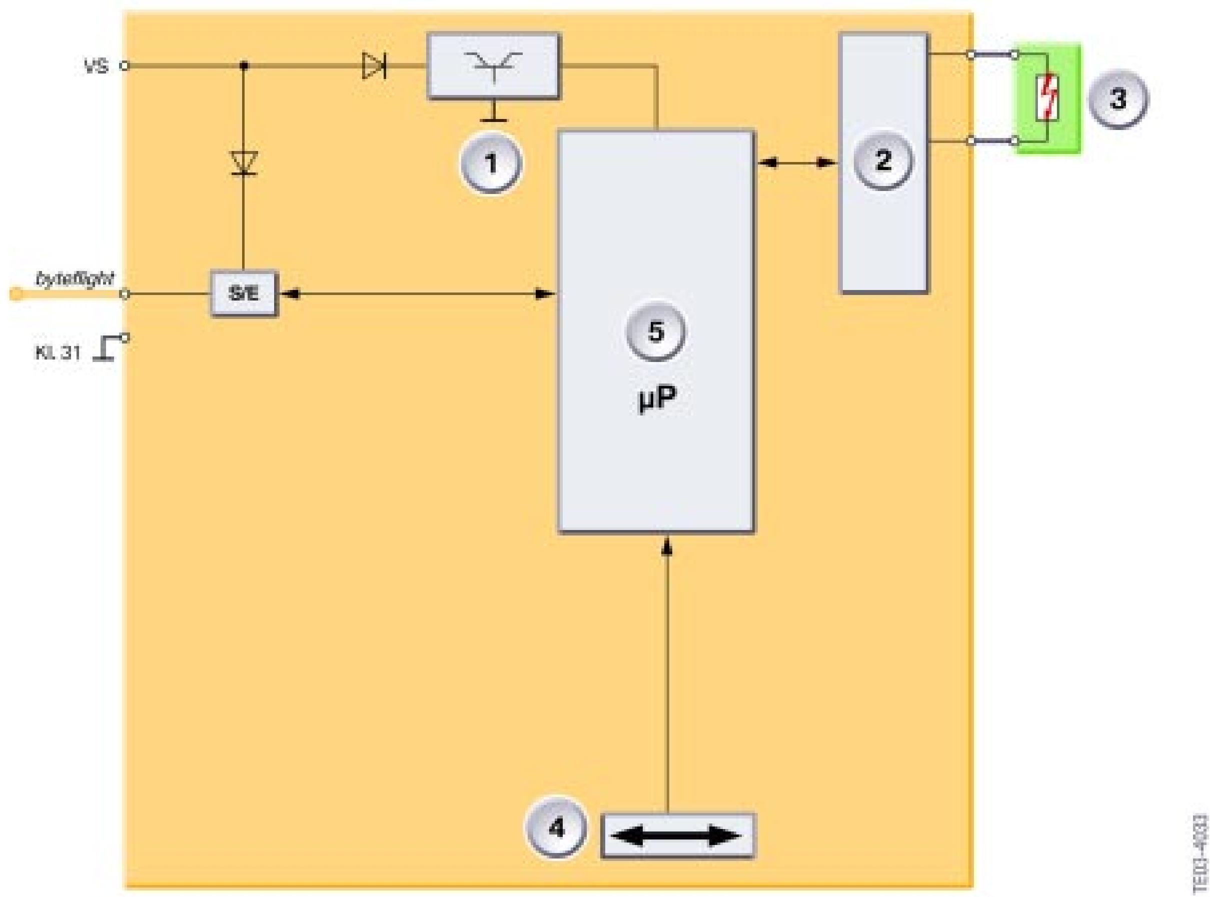
Sensors

A lateral acceleration sensor is incorporated into the SBSL. And the igniter pellets are diagnosed by ignition IC's and ignited by electrolytic capacitors. The self diagnosis of the ignition power circuits during the pre-drive check and in normal operation is the same for all satellites.

TE03-3481

Type of voltage	Voltage	Function
Voltage supply	9.5-11 V	Full Function
	11-16 V	Restricted function, diagnosis of ignition circuit not possible
Power intake	typical 80 mA	In normal operation

SBSL Schematic



Index	Explanation
VS	Power supply for satellites from SIM
S/E	Transmitter/receiver module
1	Voltage regulator
2	Ignition output stage for belt force limiter
3	Igniter pellet for belt force limiter
4	Transverse (lateral) acceleration sensor
5	Microprocessor

Right B-pillar Satellite (SBSR)

The right B-pillar satellite is installed in the B-Pillar above the seat belt inertia reel. The SBSR is connected to the SIM via ***byteflight***. The satellite power supply is also from the SIM and is buffered by the capacitor. There is an additional KL30 power supply for the operation of the electric fuel pump. When the ***byteflight*** is in sleep mode, the SBSR power supply is switched off by the SIM which also performs the software reset. The power supply to the electric fuel pump is unaffected by this.

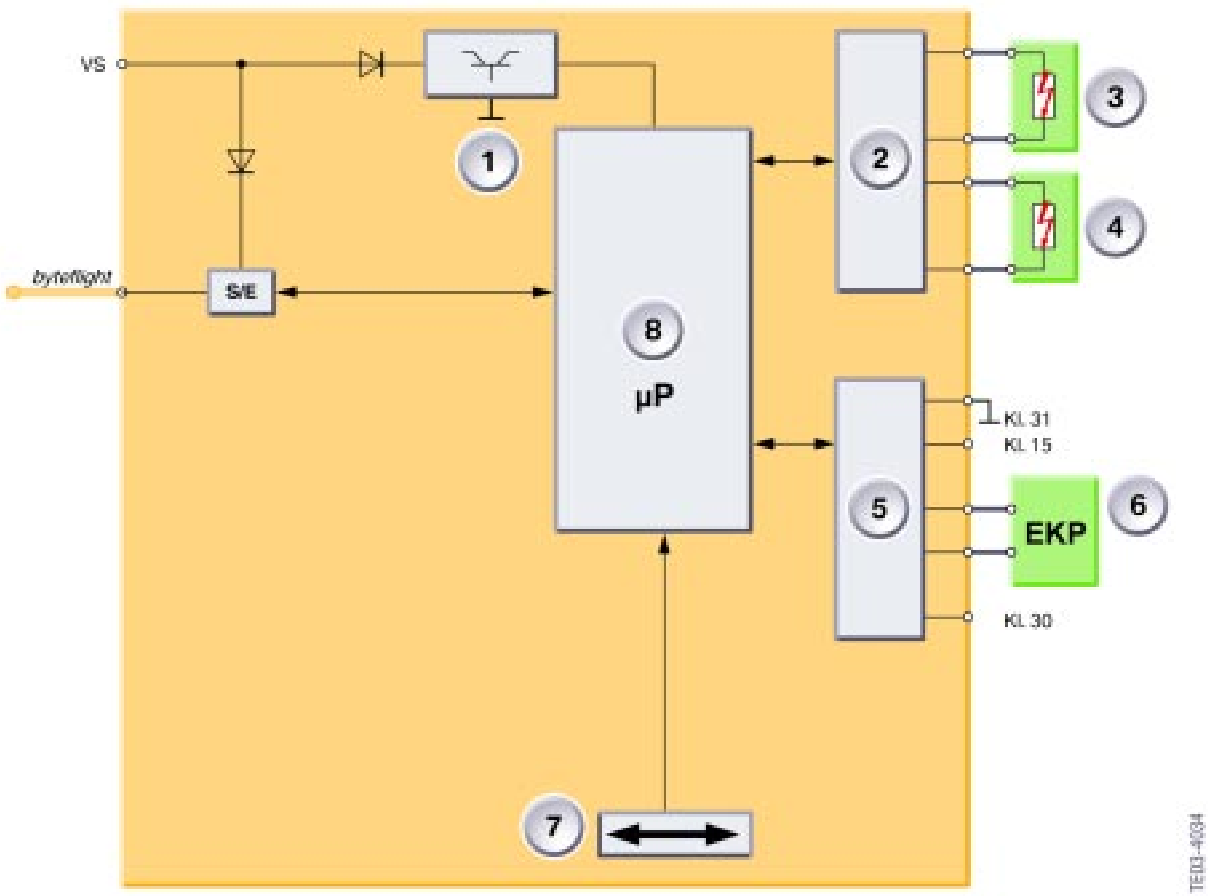
The SBSR controls and monitors the igniter pellets for the belt force limiter of the seat belt on the passenger's side and the igniter pellet. The SBSR is also responsible for the igniter circuit of the BST.

Sensors

A lateral acceleration sensor is incorporated into the SBSR. And the igniter pellets are diagnosed by ignition IC's and ignited by electrolytic capacitors. The self diagnosis of the ignition power circuits during the pre-drive check and in normal operation is the same for all satellites.

Type of voltage	Voltage	Function
Voltage supply	9.5-11 V	Full Function
	11-16 V	Restricted function, diagnosis of ignition circuit not possible
Power intake	typical 80 mA	In normal operation
Electric fuel pump power supply	6-25 V	Full function
Electric fuel pump current consumption	<50 microamps	When the fuel pump is switched off
	8A	Max. current intake by the fuel pump

SBSR Schematic



Index	Explanation	Index	Explanation
VS	9V Power supply for satellites from SIM	4	Igniter pellet for (BST)
S/E	Transmitter/receiver module	5	FInal stage for fuel pump control
1	Voltage regulator	6	Electric fuel pump
2	Ignition output stage for belt force limiter and safety battery terminal (BST)	7	Transverse acceleration sensor
3	Igniter pellet for belt force limiter	8	Microprocessor

Driver/Passenger Seat Satellite (SSFA/SSBF)

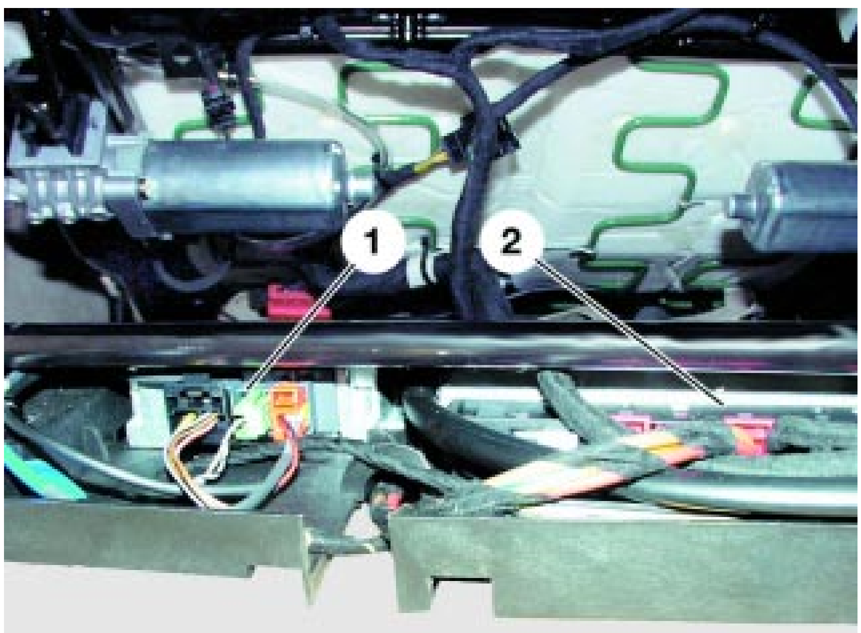
The driver and passenger seat satellites are identical. For this reason, only one is shown. The satellite is located between the seat runners. It is fitted next to the seat module in a plastic housing.

The seat satellites are connected to the SIM via ***byteflight***. The satellite power supply is also from the SIM and is buffered by the capacitor. When the ***byteflight*** is in sleep mode, the SSFA/SSBF power supply is switched off by the SIM which also performs the software reset.

The SSFA/SSBF controls and monitors the ignition circuits of the belt tensioners and the active head restraints. The belt buckles are also monitored by a hall sensor. The hall sensors are identical in design and function to those used in the E38 (from 3/97). The seat occupancy recognition is monitored via an interface in the voltage regulator.

Sensors

The SSFA/SSBF contains the seat occupancy electronics. The igniter pellets are controlled and diagnosed by ignition IC's. The self-diagnosis of the ignition power circuits during the pre-drive check and in normal operation is the same for all satellites.

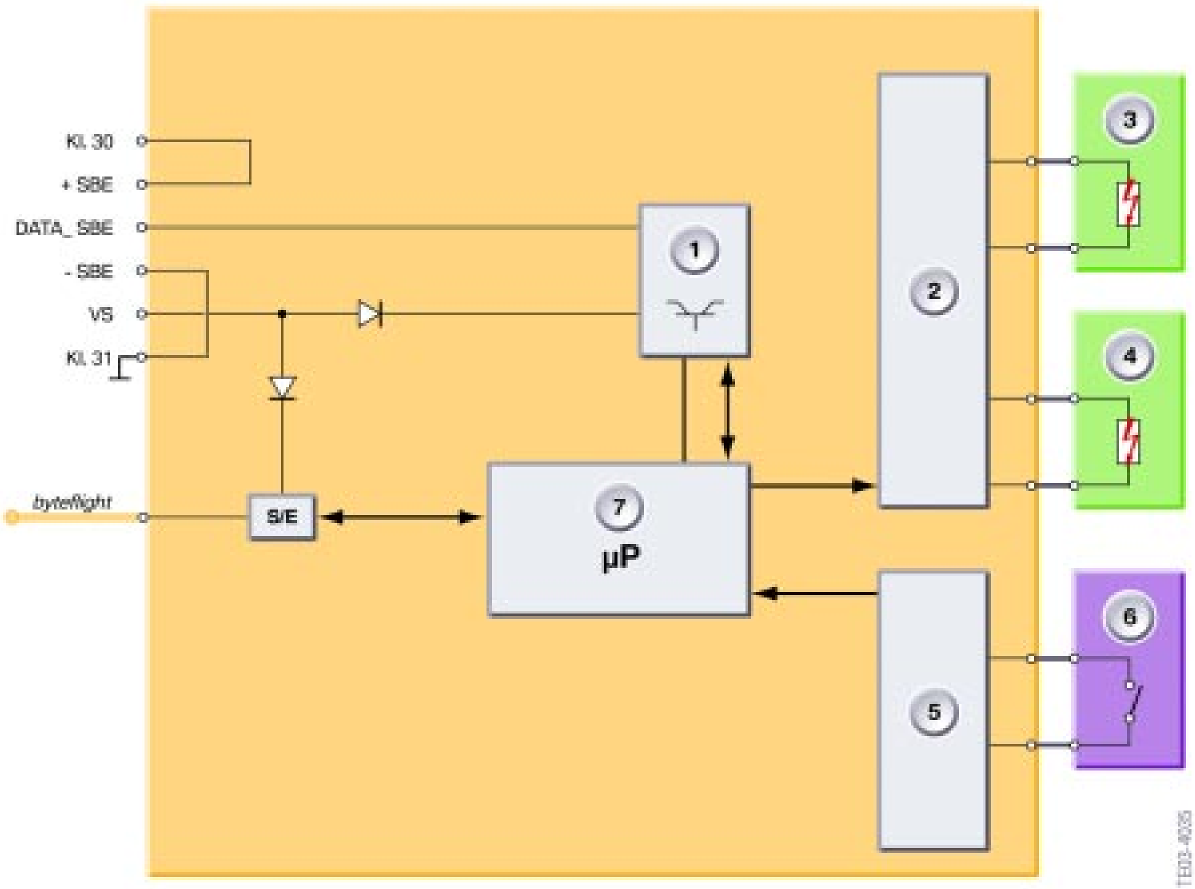


1. SSFA/SSBF

2. Seat module

Type of voltage	Voltage	Function
Voltage supply	9.5-11 V	Full Function
	11-16 V	Restricted function, diagnosis of ignition circuit not possible
Current consumption (SIM)	typical 80 mA	In normal operation
Power supply (KL30)	9-16 V	Full function
Current consumption (KL30)	30-100mA	In normal operating mode

SSFA/SSBF Schematic



Index	Explanation	Index	Explanation
KL30	Power supply (KL30)	1	Voltage Regulator
KL31	Ground connection	2	Ignition output stage
+SBE	Voltage supply for SBE	3	Igniter pellet 2nd stage for belt tensioner
DATA-SBE	SBE Signal	4	Igniter pellet for active headrest
- SBE	SBE ground connection	5	Interface for seat belt buckle switch
VS	9V power supply from SIM	6	Belt buckle switch
S/E	Transmitter receiver module	7	Microprocessor

Rear Seat Satellite SSH

The rear seat satellite is optional and part of the rear side airbag option. The SSH is installed under the rear seat.   The SSH is connected to the SIM via ***byteflight***. The satellite power supply is also from the SIM and is buffered by the capacitor. When the ***byteflight*** is in sleep mode, the SSH power supply is switched off by the SIM which also performs the software reset. The power supply to the rear seat head restraints remains unaffected.

The SSH controls and monitors the ignition power circuits of the end-fitting tensioners and the left/right rear side airbag. The left/right seat occupancy recognition is also analyzed by the SSH. The control for the head restraint height is also integrated. With the option of the comfort seats, the adjustment of the headrests is via the seat module.

Rear Headrests

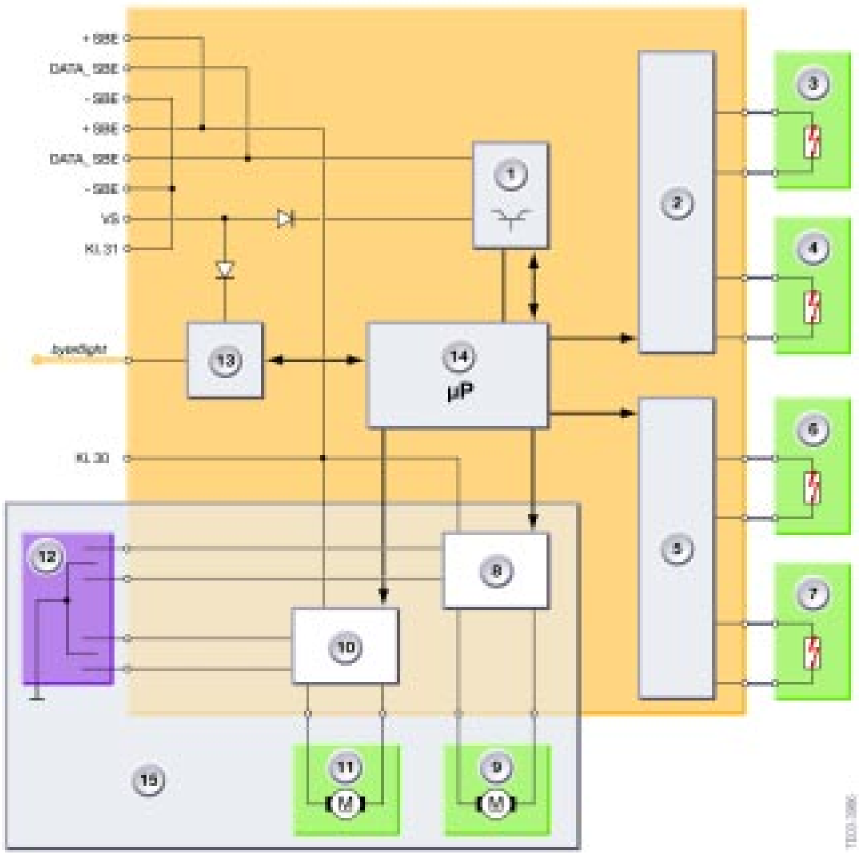
The rear head restraints are extended automatically by an electric motor if the seat occupancy recognition detects that the seat is occupied and terminal R is on. The head restraints are returned to their original position when terminal R is switched off or if the seat is not occupied.

Sensors

The igniter pellets are controlled and diagnosed by ignition IC's. The self-diagnosis of the ignition power circuits during the pre-drive check and in normal operation is the same for all satellites.

Type of voltage	Voltage	Function
Power supply (SIM)	9.5-11 V	Full Function
	11-16 V	Restricted function, diagnosis of ignition circuit not possible
Current consumption (SIM)	typical 80 mA	In normal operation
Power supply for head restraint height adjustment	9-16 V	Full function
Current consumption for head restraint height adjustment	30-100mA	In normal sleep mode
12A		Maximum current consumption by the head restraint

SSH Schematic

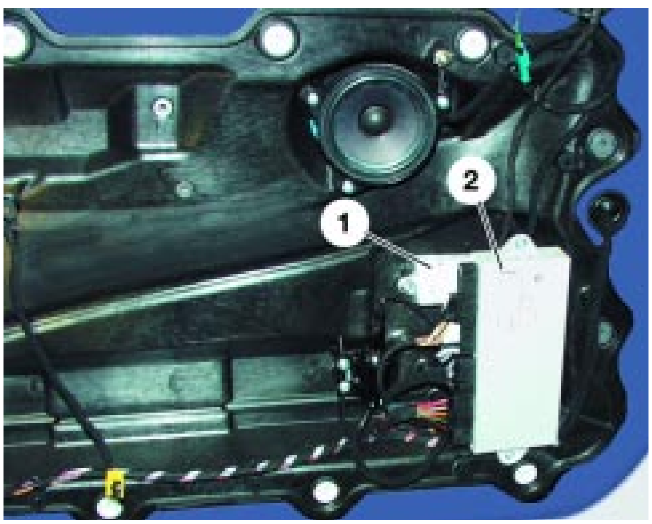


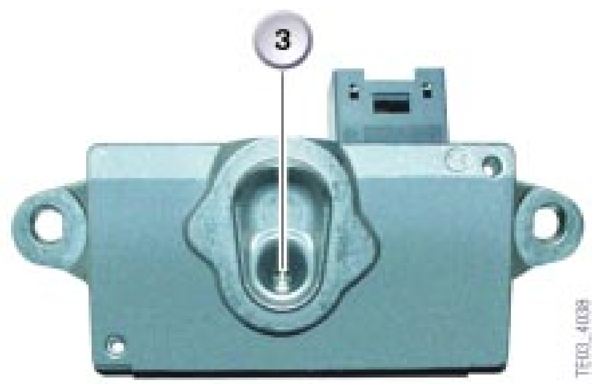
Index	Explanation	Index	Explanation
KL30	Power supply (KL30)	5	Ignition output stage for rear side airbag and left side end fitting tensioner
KL31	Ground connection	6	Igniter pellet for side airbag, rear left
+SBE	Voltage supply for SBE	7	Igniter pellet for end fitting tensioner, rear left
DATA-SBE	SBE Signal	8	Output stage for head restraint adjustment , right
+ SBE	Voltage supply for SBE	9	Drive for head restraint adjustment, right
DATA-SBE	SBE Signal	10	Output stage for head restraint adjustment , left
- SBE	SBE ground connection	11	Drive for head restraint adjustment, left
VS	9V power supply from SIM	12	Switch for head restraint height adjustment
1	Voltage regulator	13	Transmitter/receiver module
2	Ignition output stage for rear side airbag and right side end fitting tensioner	14	Microprocessor
3	Igniter pellet for side airbag, rear right	15	Optional comfort seat electronics
4	Igniter pellet for end fitting tensioner, rear right		

Front Door Satellite (STVL/STVR)

The front door satellites are installed in behind the door trim attached to the plastic inner carrier. The left and right satellites are the same. The STVL/STVR is connected to the SIM via ***byteflight***. The satellite power supply is also from the SIM and is buffered by the capacitor. When the ***byteflight*** is in sleep mode, the satellite power supply is switched off by the SIM which also performs the software reset. The STVL/R also controls and monitors the igniter pellets for the front side airbags.

Type of voltage	Voltage	Function
Voltage supply	9.5-11 V	Full Function
	11-16 V	Restricted function, diagnosis of ignition circuit not possible
Power intake	typical 80 mA	In normal operation





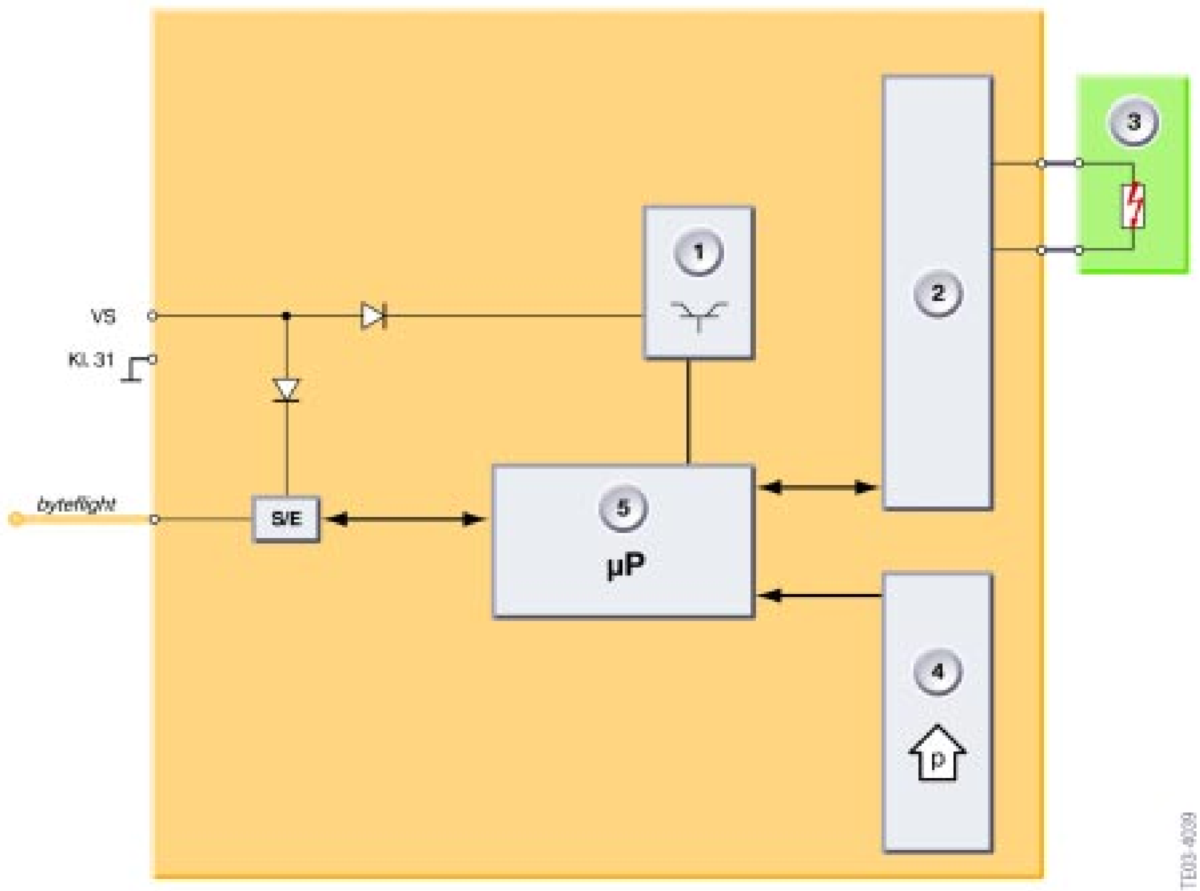
Index	Explanation
1	Door Satellite
2	Door Module
3	Measuring port for pressure sensor

Sensors

A pressure sensor is integrated into the front door satellite. The sensor reacts to an increase in pressure. If there is an impact, the space in the door is significantly reduced by the outer door panel being pushed inward, which causes a considerable increase in pressure. The relative pressure change and rise in pressure over time are the most important factors for the crash evaluation.

The igniter pellets are controlled and diagnosed by ignition IC's. The self-diagnosis of the ignition power circuits during the pre-drive check and in normal operation is the same for all satellites.

STVL/STVR Schematic



Index	Explanation
VS	9 V power supply for the satellites from the SIM
S/E	Transmitter receiver module
1	Voltage regulator
2	Side airbag ignition output stage
3	Igniter pellet for side airbag
4	Pressure sensor
5	Microprocessor

Vehicle Center Satellite (SFZ)

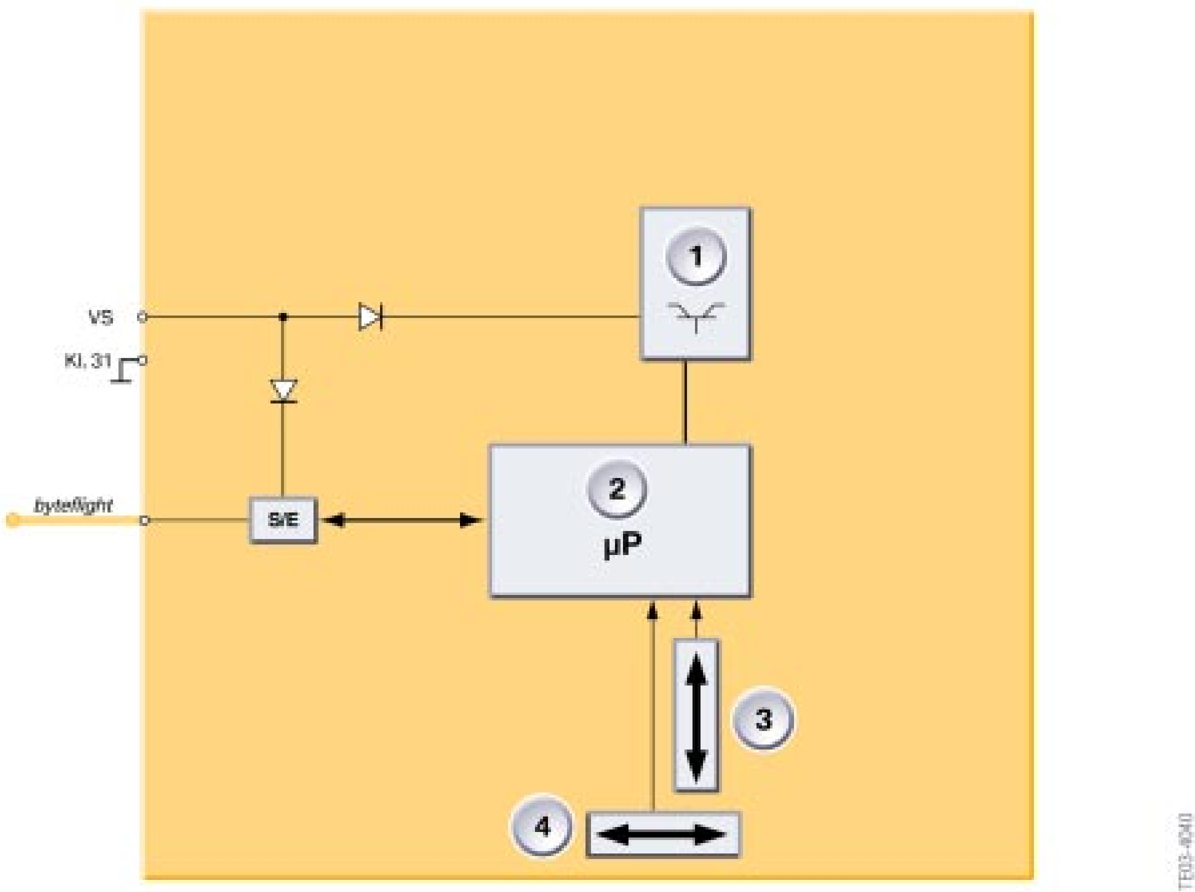
The SFZ is located underneath the center console. The SFZ is connected to the SIM via ***byteflight***. The satellite power supply is also from the SIM and is buffered by the capacitor. When the ***byteflight*** is in sleep mode, the satellite power supply is switched off by the SIM which also performs the software reset.

Sensors

The SFZ only records sensor data and therefore performs no triggering function. An acceleration sensor for longitudinal acceleration and one for lateral acceleration are integrated in the SFZ. The sensors provide a voltage signal as a measured variable. The voltage is a measurement for the vehicle acceleration.

Type of voltage	Voltage	Function
Voltage supply	9.5-11 V	Full Function
	11-16 V	Restricted function, diagnosis of ignition circuit not possible
Power intake	typical 80 mA	In normal operation

SFZ Schematic



Index	Explanation
VS	9 V power supply for the satellites from the SIM
KL31	Ground connection
S/E	Transmitter receiver module
1	Voltage regulator
2	Microprocessor
3	Longitudinal acceleration sensor
4	Transverse acceleration sensor

Steering Column Switch Cluster (SZL)

All of the components on the steering wheel and the steering column belong to the steering column switch cluster. The SZL is divided into two electronic modules. One of these electronic module is located in the steering wheel and the other is located in the steering column. Both units are interconnected by a spiral spring.

The SZL is integrated into the LSE and connected to the SIM via ***byteflight*** . The satellite power supply is also from the SIM and is buffered by the capacitor. There is also a terminal 30 for supplying non-safety relevant circuit elements and a KL15 for redundancy. In addition there are also redundant serial data lines to the AGS and light switch cluster.

The SZL controls and monitors the igniter pellets for the first and second stages of the driver's airbag. It is controlled via the spiral spring between the steering wheel and igniter pellets in the airbag.

Index	Explanation
1	MFL with function keys
2	Headlight switch (Main)
3	Transmission selector lever
4	Wiper switch
5	Button for steering wheel heating
6	Cruise control system switch
7	Button for steering column adjustment

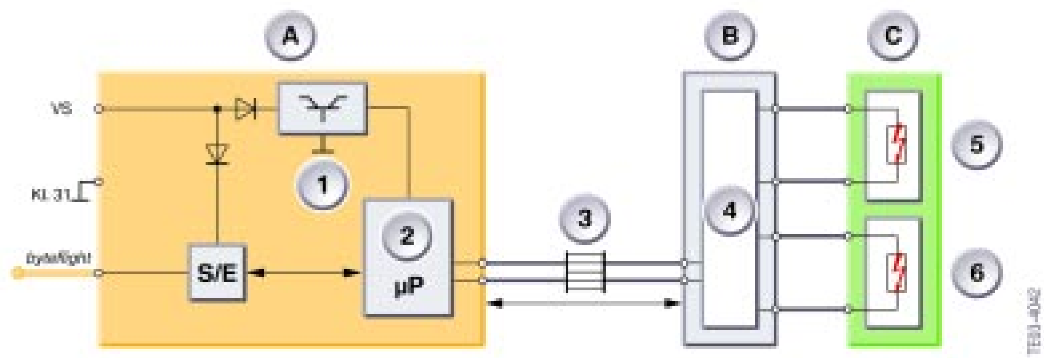
The components in the steering wheel include:

- The steering wheel heating unit with temperature sensor
- Steptronic buttons
- The horn buttons
- The left and right multi-function switch blocks
- The front driver airbag (with igniter pellets)
- The steering wheel electronics (LRE)

The components in the steering column include:

- The steering column module with ***byteflight*** connection
- The steering angle sensor
- The light switch
- The wiper switch
- The cruise control switch
- The transmission selector lever
- The steering wheel heating button
- The switch for the steering wheel lock
- The switch for the steering column adjustment
- The coil springs

The connection between the two components is the spiral spring which transfers both signals and power.



Index	Explanation
A	Satellite with steering column electronics
B	Steering wheel electronics
C	Airbag
VS	Power supply for satellites from SIM
S/E	Transmitter/receiver module
KL31	Ground connection
1	Voltage regulator
2	Microprocessor
3	Coil spring
4	Driver’s airbag ignition output stage
5	Driver’s airbag igniter pellet, Stage 1
6	Driver’s airbag igniter pellet, Stage 2

Type of voltage	Voltage	Function
Voltage supply	9.5-11 V	Full Function
	11-16 V	Restricted function, diagnosis of ignition circuit not possible
Power intake	typical 80 mA	In normal operation

Workshop Exercise - ISIS

Perform the test module for setting system time. List the correct pathway to access the test module:

Why is it important to set system time? And when should this be done?

Disconnect an instructor designated satellite. Perform complete quick test and follow test module.

What did the test module conclude as the root cause?

Leaving the satellite disconnected, go to the function selection menu and select "Bus functions" and go to the byteflight test. Perform "communication test".

Once complete go to optical test.

What tool is recommended for the "optical test"?

Perform all necessary optical tests as per test module.

What is the maximum allowable attenuation on the byteflight bus?

Workshop Exercise - ISIS

How many repairs are allowed between control modules on ***byteflight***?

Using the proper cables/tools, measure the current consumption of a byteflight satellite.

What is the observed current?

What is the specified current?

Interrupt the power supply to the satellite (without disconnecting byteflight).

What is observed regarding the fault codes in the system pertaining to this fault?

Following the test module for this concern.

What is concluded in the test module?

Classroom Exercise - Review Questions

1. What makes it possible for the ISIS system to react faster than previous passive safety systems such as MRS?

2. What 2 passive safety systems use ***byteflight*** fiber optic technology?

3. On the ISIS system, which component acts as a gateway between the D-bus, K-CAN, PT-CAN and the ***byteflight***?

4. What are the 3 main tasks of the SIM in the ISIS system?

5. What are the three faults that would cause the SIM to cut off power supply to the satellite?

6. What is the typical current consumption of the satellites in the ISIS system?

7. In the ISIS system, which satellite does not contain circuitry for triggering any ignition circuits?

8. Which ISIS satellite controls the fuel pump?

9. What must be done after the installation of a new satellite module?

10. Into which component are the SZL electronics located?

11. Which satellites are capable of waking the ***byteflight***?

12. Which ***byteflight*** satellite controls the rear headrests (if equipped)?

13. Where is the ZGM located on the E65?

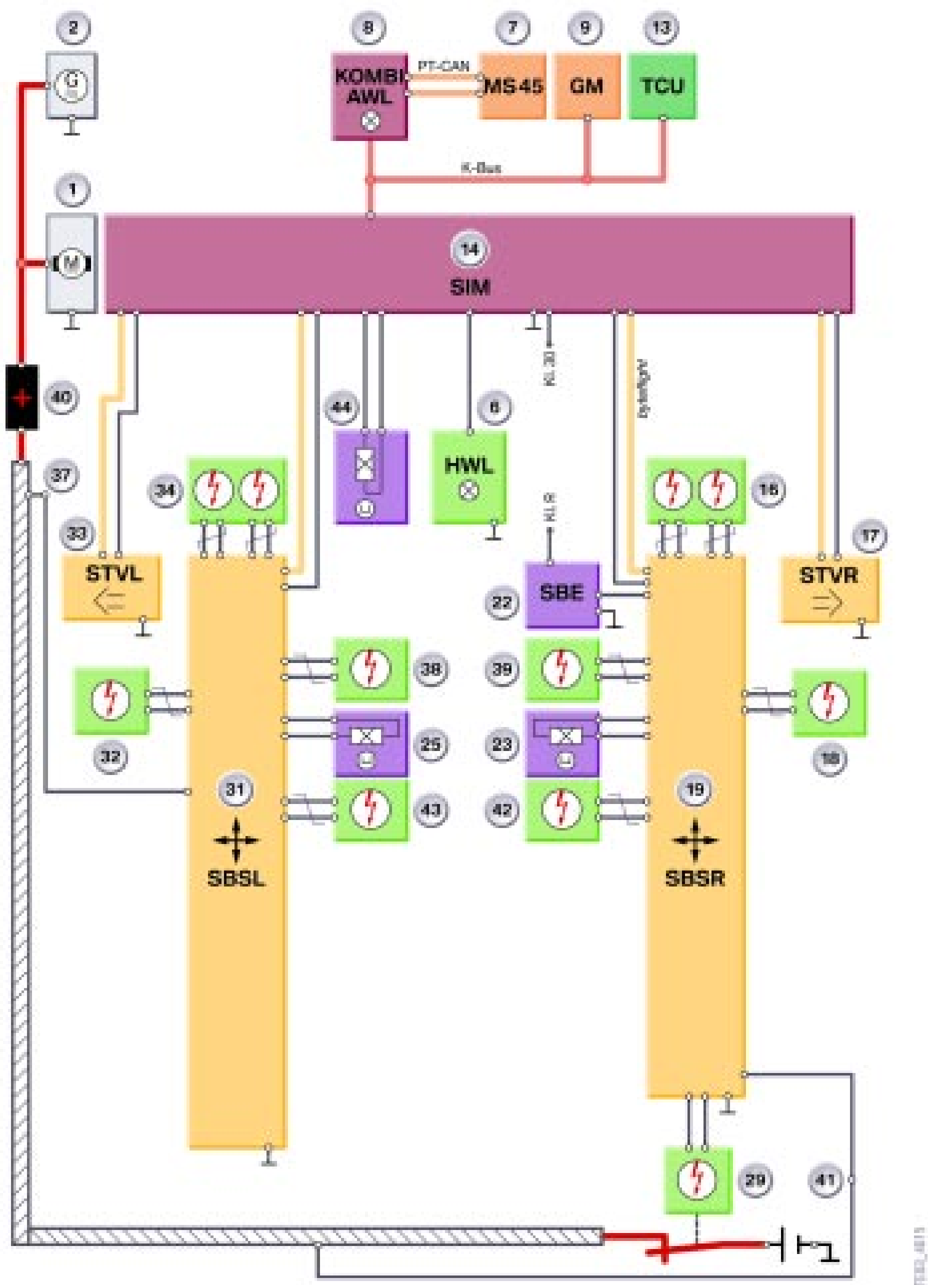
Review Notes:

Advanced Safety Electronics (ASE)

The ASE system is a ***byteflight*** based passive safety system which utilizes the same technology as ISIS. The system was introduced on the E85 and subsequently fitted to the E60, E63 and E64.

The technology used in the ASE system offers the same benefits and advantages that ISIS offers. Many of the components used on ASE are carried over from ISIS with some noteable differences.

ASE System Overview (E85)



Legend for E85 System Overview

Index	Explanation	Index	Explanation
1	Starter	29	Battery safety terminal (BST)
2	Alternator	31	B-pillar satellite, left
6	Warning lamp (airbag deactivation)	32	Side airbag, driver's side
7	DME control unit (ECM)	33	Door satellite, front left
8	Instrument cluster	34	Front airbag, driver
9	General Module (GM5)	37	B+ cable diagnosis connection (engine comp)
13	Emergency call button	38	Knee airbag, driver
14	Safety and Information Module	39	Knee airbag, passenger
16	Front airbag, passenger	40	B+ connection (engine compartment)
17	Door satellite, front right	41	B+ cable diagnosis connection (luggage comp)
18	Side airbag, passenger side	42	Seat belt tensioner, passenger
19	B-pillar satellite, right	43	Seat belt tensioner, driver
22	Seat occupancy detection	44	Passenger airbag , deactivation
23	Belt buckle switch, passenger side	KL30	Terminal 30
25	Buckle switch, driver	KLR	Terminal R

The ASE system in the E85 differs considerably from the ISIS system. Most notably there are fewer satellites in the system. There are only 4 satellites connected to the SIM. These include the STVL, STVR, SBSL and SBSR.

There are some additions to the ASE system as well. Since the E85 is a roadster with no back seat, a switch for airbag deactivation has been added to allow the installation of a front child seat if needed (up to 9/2003). The switch, which is actuated using the vehicle key, will deactivate the passenger front, side and knee airbags.

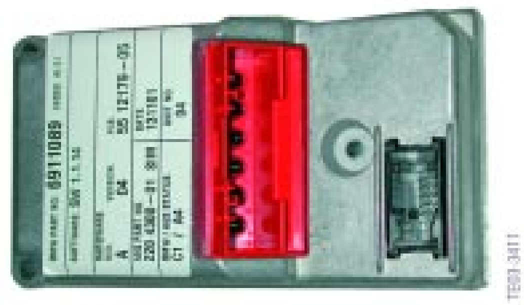
Also new for the E85 is the battery cable monitoring circuit. Since the battery cable on the E85 is routed on the exterior, rather than the interior on previous models, there is now a monitoring circuit used. This protects the battery cable from short circuits by activating the BST. This circuit is routed through the SBSL and SBSR.

Some of the familiar components carried over from the ISIS have been modified for use in the E85 ASE system. The SIM, SBSL and SBSR now incorporate acceleration sensors to detect impacts. Previously, in ISIS, these acceleration sensors were distributed to other satellites which are not used on the E85.

ASE System Components (E85)

Safety and Information Module

The SIM is located under the center console in the E85. The SIM is responsible for the following functions:



- The satellite power supply. Reserve power supply in the event of a power loss during an accident. (Power reserve 33V)
- The function of the star coupler (4 S/E modules) and the ***byteflight*** bus main controller (master)
- Receives input from passenger airbag deactivation switch
- Acts as gateway between ***byteflight*** and K-bus
- Provides crash report for triggering various functions in other systems
- Actuates warning circuit for “Passenger Airbag Off” lamp in center console
- Contains lateral and longitudinal acceleration sensors.

The values are transferred to all the satellites via the ***byteflight***, in the same way as the values measured by the satellites. These measured values are used by the algorithms in the satellites. The SIM compares the values and, if the impact is of sufficient severity, it uses the synchronization pulses to initiate alarm mode.

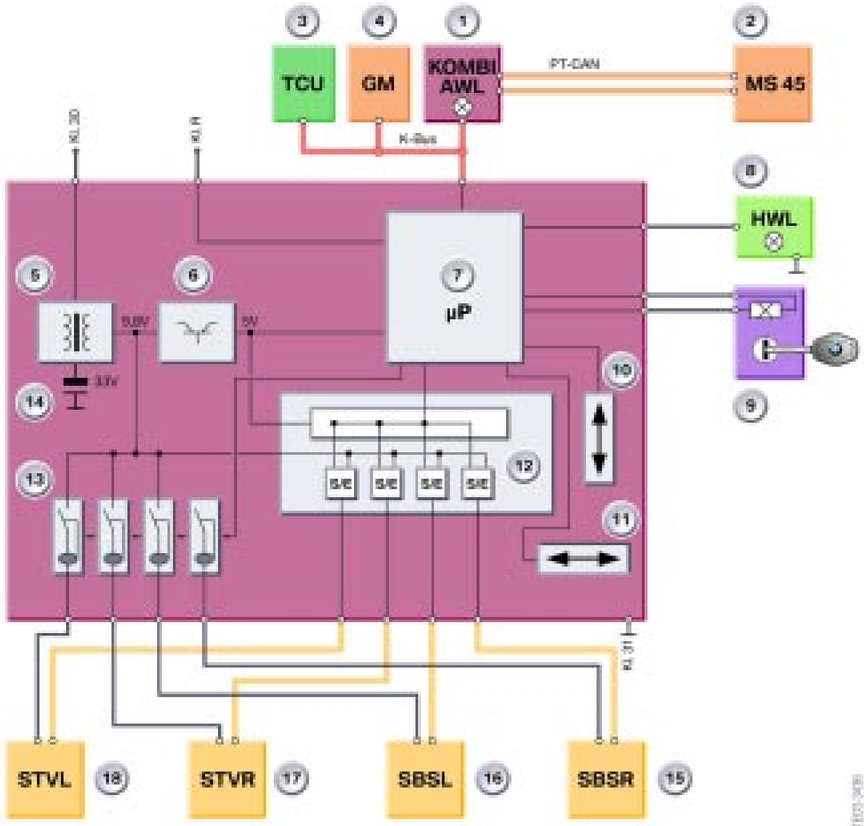
The alarm mode places the satellites in a triggerable state. The actuators required are actuated, depending upon the accident severity and the stored algorithms.

If the passenger airbag deactivation switch is set to “off”, the passenger side airbag, knee airbag and passenger side door airbag will not be deployed.

The SIM is centrally mounted and incorporates the lateral and longitudinal acceleration sensors, this allows the SIM to replace the SFZ used in the ISIS.

As far as diagnosis is concerned, the SIM carries out two functions (SIM, ZGM). These functions, although in a common housing, have separate diagnostic addresses and use separate microprocessors.

SIM Schematic (E85)



Index	Explanation	Index	Explanation
1	Instrument cluster	13	Intelligent Distributor
2	DME control unit (ECM)	14	Power reserve
3	Telematic Control Unit (TCU)	15	B-pillar satellite, right
4	General Module (GM5)	16	B-pillar satellite, left
5	Switching controller	17	Door satellite, right
6	Voltage regulator	18	Door satellite, left
7	Microprocessor	19	Battery
8	Switch for airbag deactivation	20	Ignition Switch
9	Warning lamp for airbag deactivation	S/E	Transmitter/receiver module
10	Longitudinal acceleration sensor	KLR	Terminal R
11	Transverse acceleration sensor	KL30	Terminal 30
12	Intelligent Star Coupler	KL31	Terminal 31

Left B-pillar Satellite (SBSL)

The SBSL is located at the bottom of the B-pillar on the driver's side of the vehicle. It is connected to the SIM via ***byteflight***. The SBSL is responsible for the following:

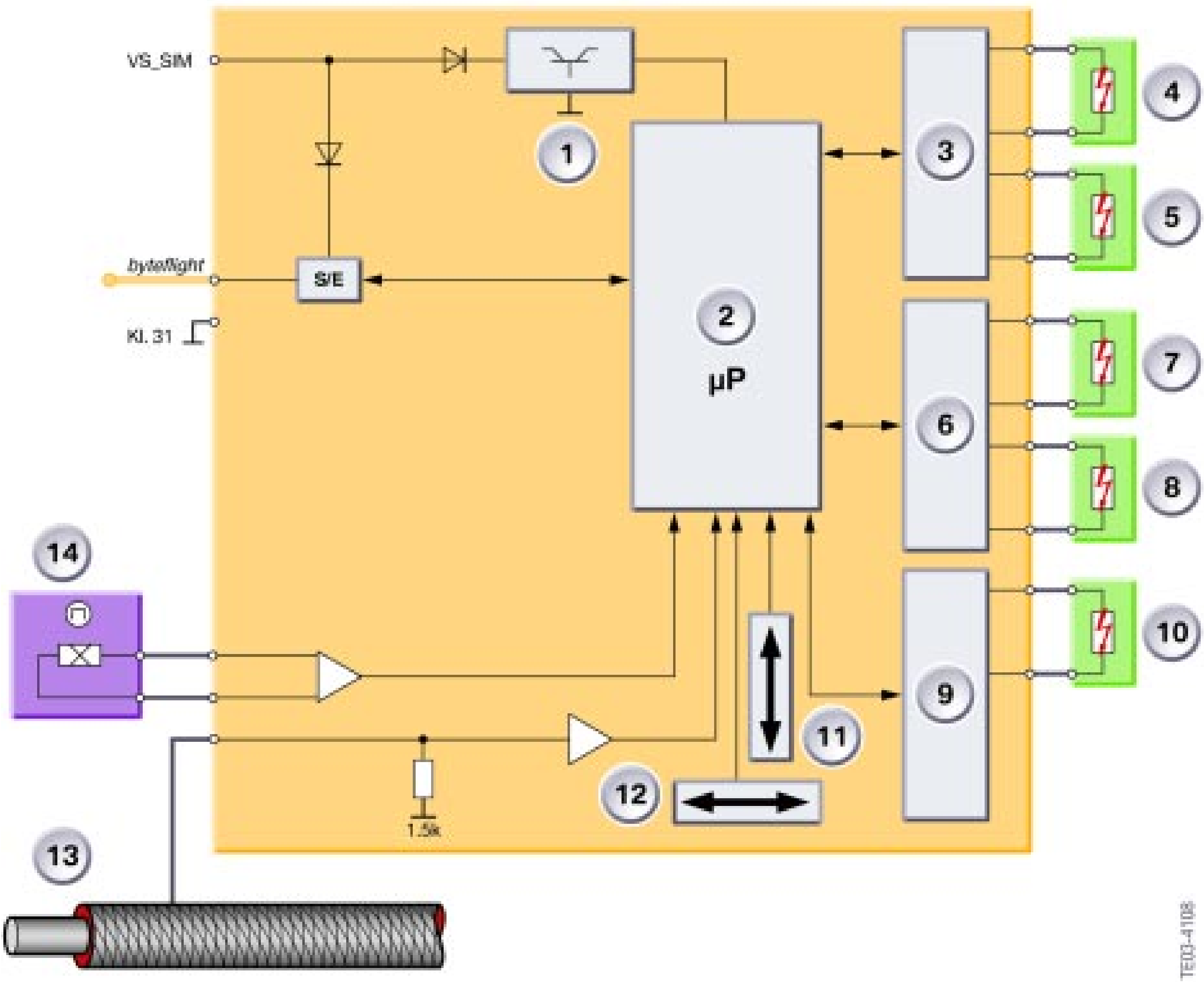
- Control and monitoring of the driver's airbag.
- Control and monitoring of the driver's side door airbag.
- Control and monitoring of the left side seatbelt tensioner.
- Control and monitoring of the left knee airbag.

The SBSL also contains a portion of the battery cable monitoring circuit (engine compartment connection).

The SBSL also contains longitudinal and lateral acceleration sensors. The positive and negative acceleration values are provided as continuous voltage values and transferred via the ***byteflight*** to the SIM and the other satellites.

Type of voltage	Voltage	Function
Voltage supply	9.4-10.7 V	Full Function
Voltage supply	10.7-16 V	Restricted function, diagnosis of ignition circuit not possible
Current consumption	typical 90 mA	In normal operation

SBSL Schematic



Index	Explanation	Index	Explanation
1	Voltage regulator	10	Igniter pellet, knee airbag
2	Microprocessor	11	Longitudinal acceleration sensor
3	Ignition output, stage 1	12	Transverse acceleration sensor
4	Front airbag igniter pellet, stage 1	13	Battery cable diagnosis connection (engine compartment)
5	Front airbag igniter pellet, stage 2	14	Belt buckle switch, left
6	Ignition output, stage 2	KL31	Terminal 31
7	Igniter pellet for side airbag	S/E	Transmitter/receiver module
8	Igniter pellet, belt tensioner left	VS_SIM	Voltage supply (from SIM)
9	Ignition output, stage 3 (knee airbag)		

Right B-pillar Satellite (SBSR)

The SBSR is located at the bottom of the B-pillar on the passenger side of the vehicle. It is connected to the SIM via ***byteflight***. The SBSR is responsible for the following:

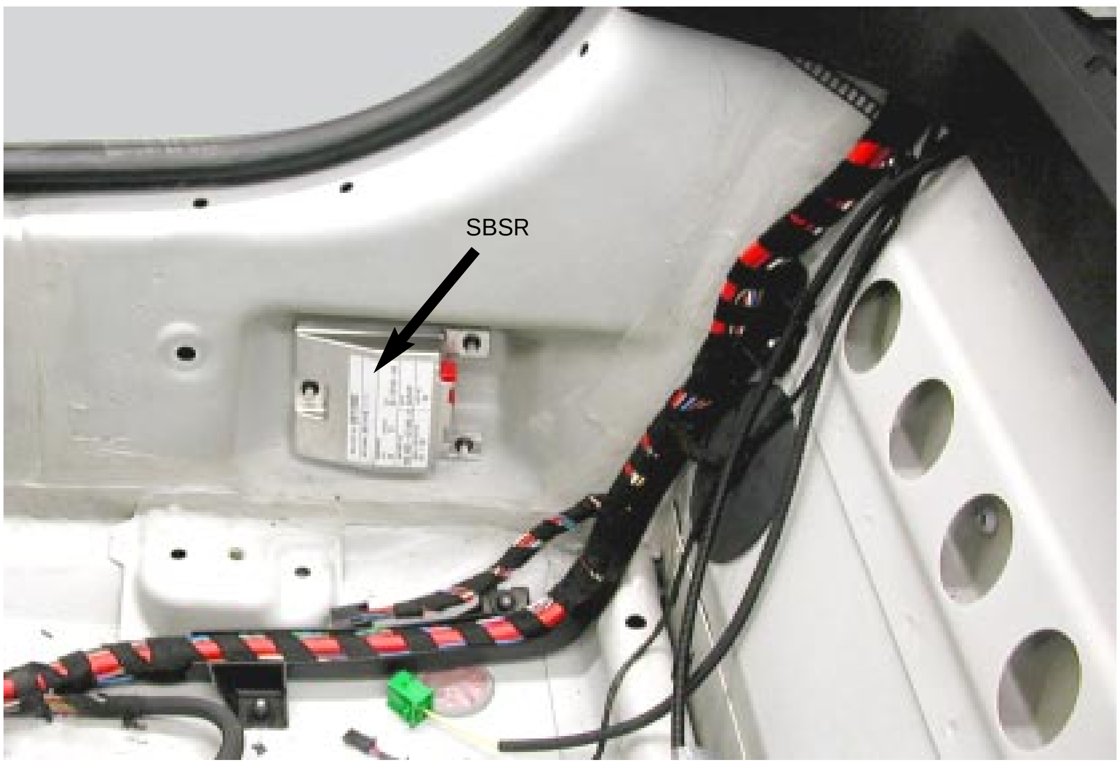
- Control and monitoring of the passenger front airbag.
- Control and monitoring of the passenger side door airbag.
- Control and monitoring of the right side seatbelt tensioner.
- Control and monitoring of the right knee airbag.

* Control and monitoring of the BST

* Monitoring of the SBE circuit

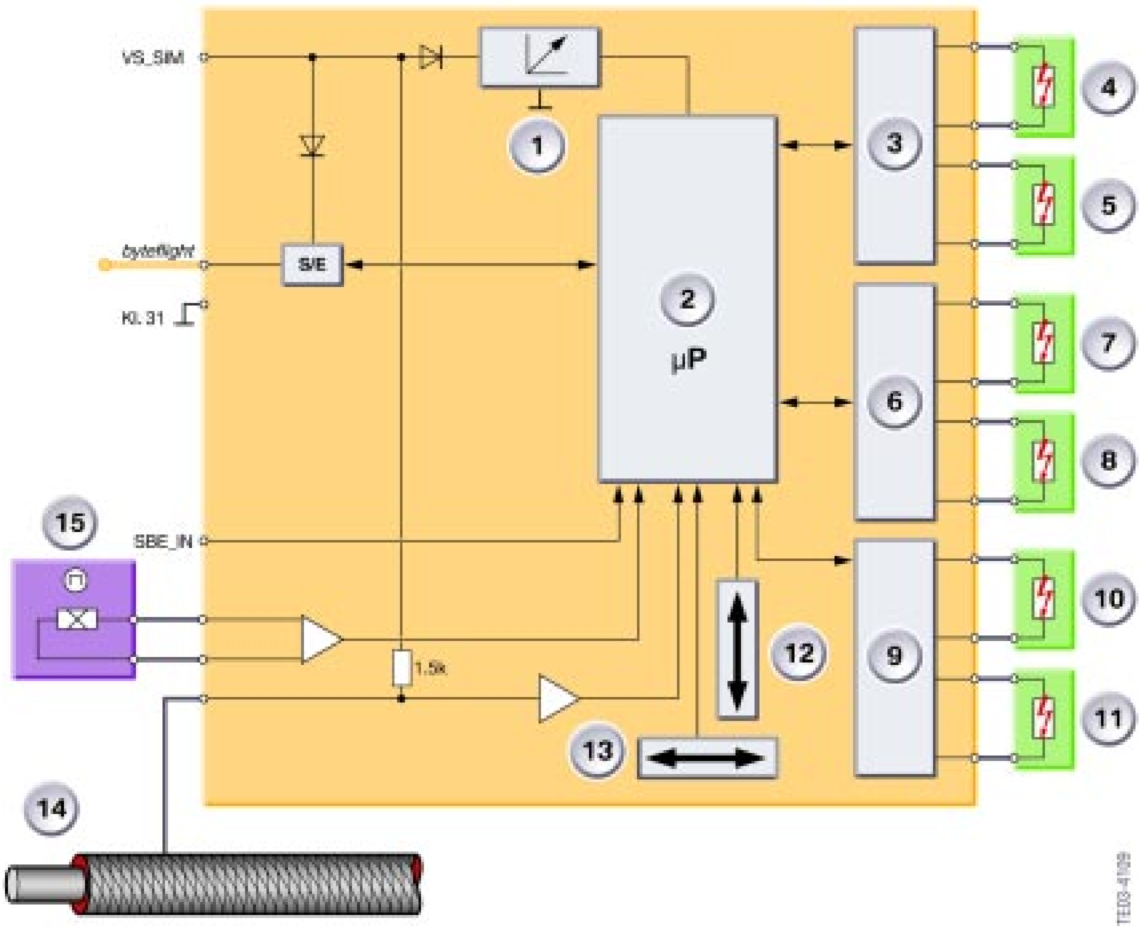
The SBSR also contains a portion of the battery cable monitoring circuit (luggage compartment connection).

The SBSR also contains longitudinal and lateral acceleration sensors. The positive and negative acceleration values are provided as continuous voltage values and transferred via the ***byteflight*** to the SIM and the other satellites.



Type of voltage	Voltage	Function
Voltage supply	9.4-10.7 V	Full Function
Voltage supply	10.7-16 V	Restricted function, diagnosis of ignition circuit not possible
Current consumption	typical 90 mA	In normal operation

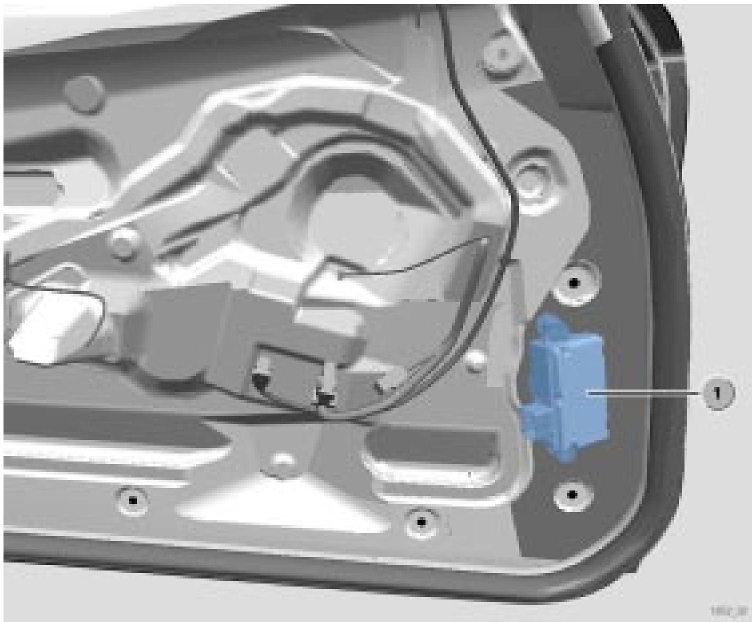
SBSR Schematic



Index	Explanation	Index	Explanation
1	Voltage regulator	11	Igniter pellet, knee airbag
2	Microprocessor	12	Longitudinal acceleration sensor
3	Ignition output, stage 1	13	Transverse acceleration sensor
4	Front airbag igniter pellet, stage 1	14	Battery cable diagnosis connection (luggage compartment)
5	Front airbag igniter pellet, stage 2	15	Belt buckle switch, right
6	Ignition output, stage 2	KL31	Terminal 31
7	Igniter pellet for side airbag	S/E	Transmitter/receiver module
8	Igniter pellet, belt tensioner right	VS_SIM	Voltage supply (from SIM)
9	Ignition output, stage 3 (knee airbag)	SBE-IN	Seat occupancy detection
10	Igniter pellet for BST		

Left and Right Door Satellites (STVL/STVR)

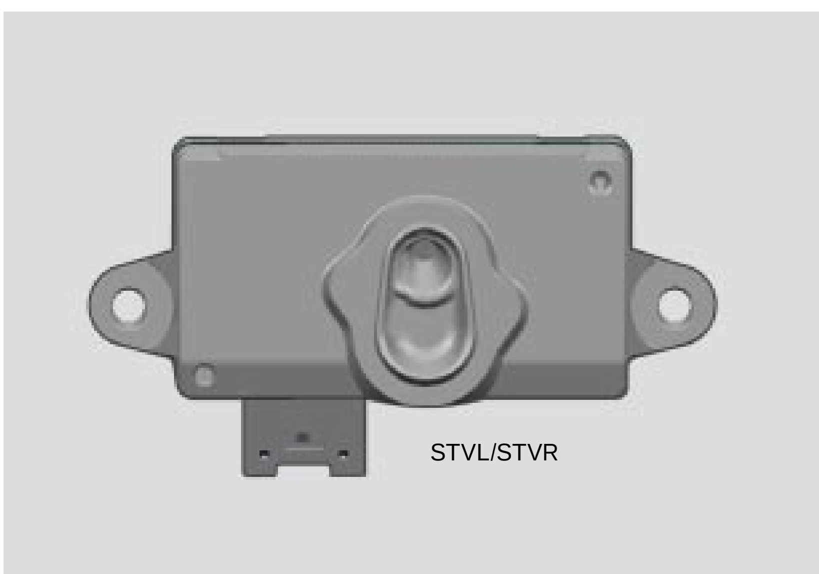
The STVL/STVR is located on the right and left hand doors respectively. These satellite provide crash information by sensing the pressure in the door cavity. Upon side door impact, the sudden pressure increase is detected by the sensor. This information is processed and sent to the SIM via ***byteflight***.



1. STVL/STVR

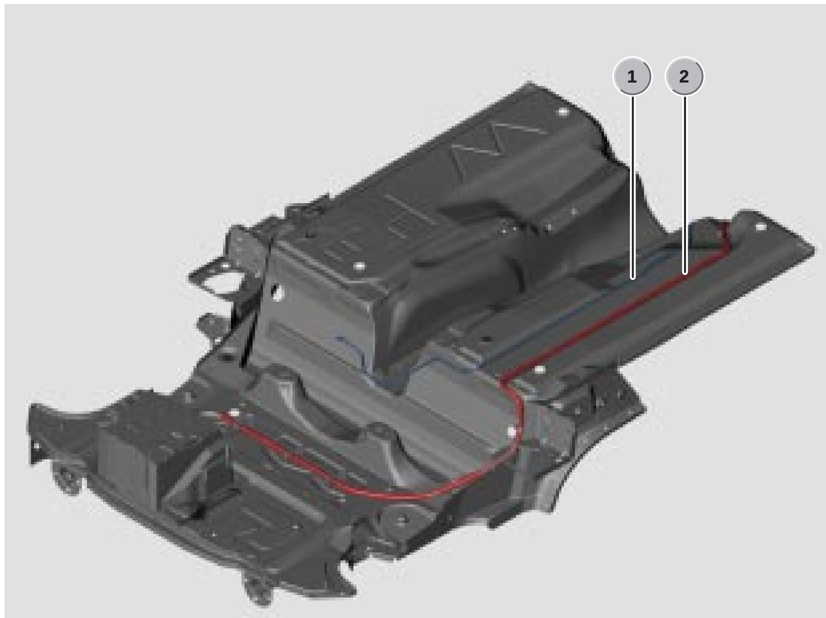
The measured values are also transferred across the ***byteflight*** in parallel to the other satellites.The power supply of the satellite is also from the SIM and it is buffered by the memory backup capacitor. In sleep mode of the ***byteflight***, the power supply of the STVL/R is deactivated by the SIM.

The STVL and STVR do not contain any acceleration sensors or ignition circuits.

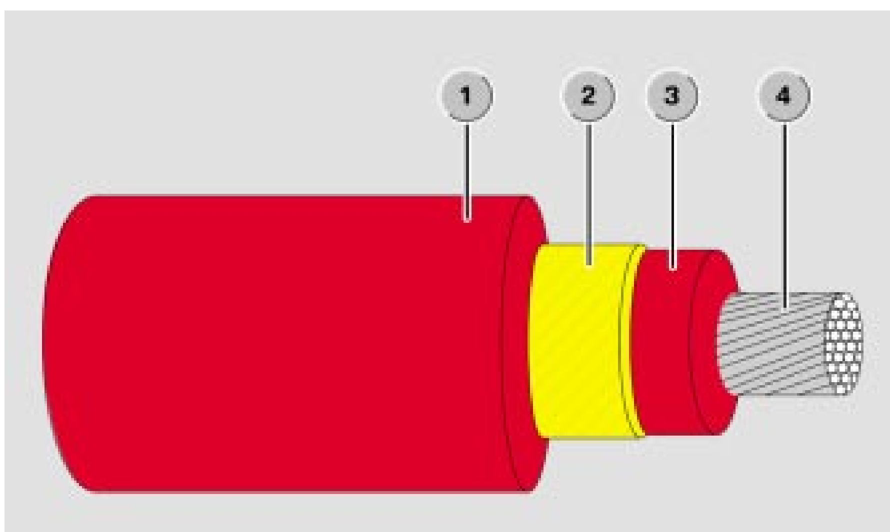


B+ Cable Monitoring

The E85 B+ Battery Cable is routed from trunk area along the underside of the car into the engine compartment. If the cable is damaged in an accident or while driving over an obstacle, the BST is activated, protecting the vehicle from further electrical problems.



The battery cable on the E85 is fitted with a low impedance metal mesh. This mesh surrounds the B+ cable insulation and is also covered by an additional insulation. The metal mesh is referred to as the monitoring shield.

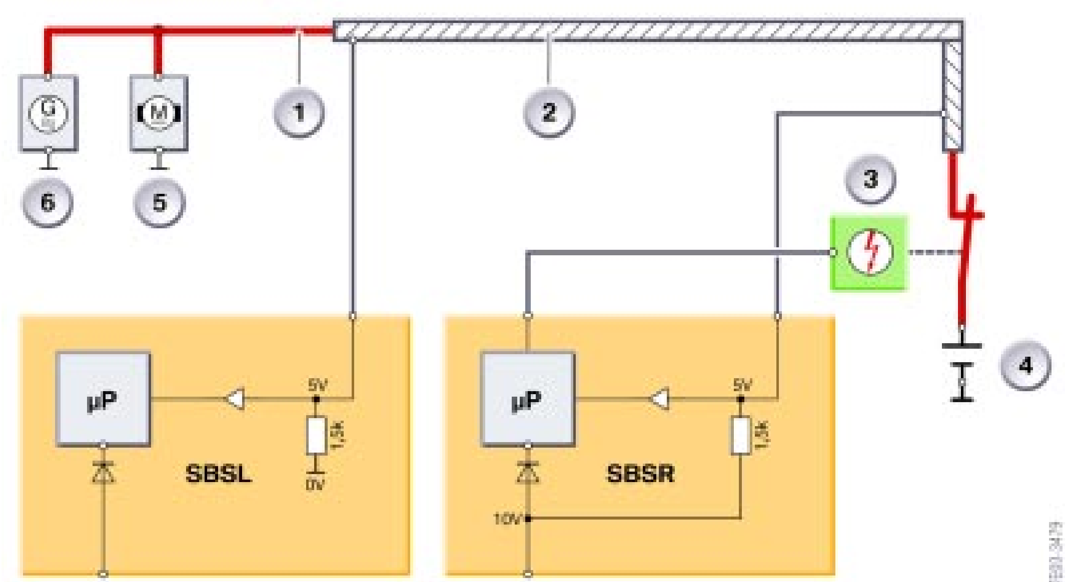


Index	Explanation	Index	Explanation
1	Outer insulation	3	Battery cable insulation
2	Monitoring shield (metal mesh)	4	Battery cable (aluminum conductor 120 mm^2)

Battery Cable Monitoring Circuit

The battery cable is diagnosed by a special circuit between the SBSL and SBSR satellites. The battery cable diagnosis takes place across the low impedance shield of the battery cable (monitoring shield).

There are connections to the left B-pillar satellite and the right B-pillar satellite at both ends of the shield. This means that there is usually the same voltage at the analog/digital converters in the satellites. If the voltages differ, there is a fault.



Index	Explanation	Index	Explanation
1	Battery cable	4	Battery
2	Monitoring shield (metal mesh)	5	Starter
3	Battery Safety Terminal (BST)	6	Generator

The monitoring shield consists of a low-impedance metal mesh. A connection cable exits from each end of the monitoring shield (at the safety battery terminal in the luggage compartment and at the battery ground point in the engine compartment).

The connection at the safety battery terminal in the luggage compartment is connected to the right B-pillar satellite. The second connection cable in the engine compartment is connected to the left B-pillar satellite.

The satellites contain analog/digital converters that are connected to the microprocessor of the satellite. The connection cables of the battery cable diagnosis are connected to the A/D converters. The right B-pillar satellite contains a pull-up resistor. The left B-pillar satellite contains a pull-down resistor of the same size.

The voltage supply of the satellite (approx. 10 V) is applied at the pull-up resistor. Ground is applied at the pull-down resistor.

The very low-impedance cable and the resistors of the same size mean that around half the voltage (approx. 5 V) is applied at the A/D converters.

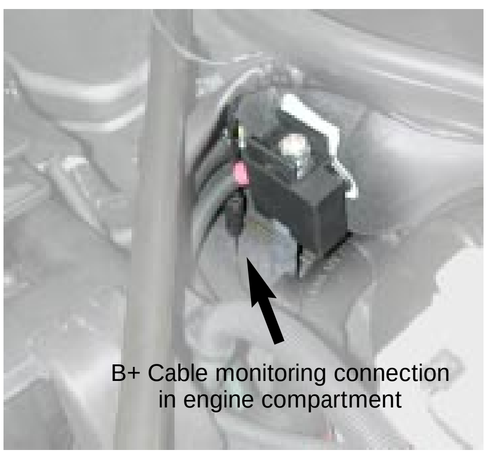
In the event of a fault, significantly different measured values would result as follows:

State	Measured value at SBSL	Measured value at SBSR
Battery cable OK	Approximately 5 Volts	Approximately 5 Volts
Interruption (open) of B+ cable diagnosis connection	Approximately 0 Volts	Approximately 10 Volts
Short circuit to ground	Approximately 0 Volts	Approximately 0 Volts
Short circuit to B+ (KL30)	Approximately battery voltage	Approximately battery voltage

Every 250 ms, the values are measured, triggered by the synchronization pulse. If the battery cable is OK, the values are transferred every 20 ms to the SIM. If a significant deviation of the values occurs, the new values are transferred immediately.

In the following cases, the battery cable is cut off by the safety battery terminal from the battery and the alternator is switched off:

- Short circuit to ground (body)
- Short to battery positive



Battery cable with monitoring connection
(note - BST side of cable)

1. Monitoring connection 2. Battery cable

If the outer insulation is damaged (e.g. due to friction/scuffing), but the monitoring shield has no connection to ground, the following case could occur:

Moisture (rain) would mean that the voltage would gradually fall. A short circuit to ground would be detected, but the safety battery terminal would not be triggered.

The entry "Implausible measured value" is set in the fault code memory. This would be indicated to the driver by the airbag warning lamp.

Battery Cable Diagnosis
If the shielding of the battery cable is damaged, the battery cable must be replaced completely. It is not permitted to perform repairs to the shielding.

Passenger Airbag Deactivation

Due to the fact that the E85 is a 2 seat roadster, there is a need to deactivate the passenger airbag to accommodate children and child seats. A switch has been added to allow this function to be possible.

The switch, which is actuated by the vehicle key, is located on the right side of the dashboard near the a-pillar. Access to the switch is only possible with the passenger door open. This prevents any “accidental” or unwanted switch actuation while the vehicle is in motion.

The airbag switch is an input to the SIM. Once the SIM detects an “off” request from the switch, the passenger side airbag, door airbag, seatbelt tensioner and knee airbag are deactivated.

The SIM also activates the “Passenger Airbag Off” indicator light which is located in the center console. The indicator light contains several LED’s which are controlled by the SIM. The SIM also monitors the indicator light during the self check. The AWL will be illuminated if any faults are detected.

Seat Occupancy Detection (SBE)

As with previous BMW models, the passenger seat is monitored by the SBE system. The SBE system in the E85 operates the same as previous SBE systems. The seat “recognition” signal is sent to the passenger side b-pillar satellite. This configuration is used until 9/2003 production.

From 9/2003 production, the E85 has adopted the OC-3 seat occupancy recognition system. The airbag off switch has been retained in the event that a passenger may be too close to the deactivation threshold. Due to the fact that the E85 is a roadster, there is no option of sitting in the rear. The deactivation switch allows the airbag to be shut off when needed.

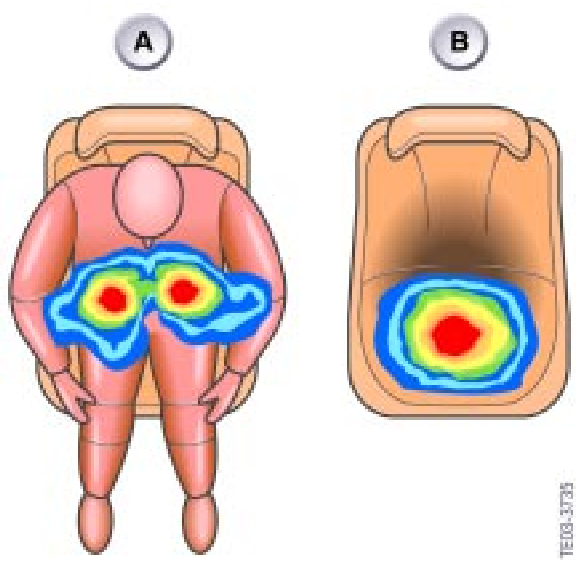
Passenger Seat Occupancy Detection (OC-3)

As of 9/2003, the new occupancy detection system has been added to the E85. Current governmental safety regulations make it necessary for the passive safety system to be able to determine the approximate size and weight of the passenger. This enables the system to deactivate the passenger side airbag when traveling with a child or an infant in a child seat.

To accomplish this, the existing SBE system was subsequently developed into the new “intelligent occupant classifier” (**O**ccupant **C**lassification) or OC-3 system. This was achieved by:

- Adding a larger number of “force sensitive” resistance elements.
- Dividing the detection mat into zones which cover the entire seat area.
- Using an intelligent electronic analyzer.

The OC-3 sensor mat is capable of distinguishing between a one-year old child in a child seat and a light person. This is done by analyzing the distribution of weight across the seat. For example, a child in a child seat would be distinguished from a 90 pound adult by the contact pattern. In other words, the contact pattern of a child seat would differ considerably from an adult due to the spacing of the hip bones vs. the child seat “rails”.



The OC-3 sensor mat is integrated into the lower seat pad area of the passenger seat. The mat consists of conductors with pressure-dependent resistor elements also known as FSR (Force Sensitive Resistance) elements.

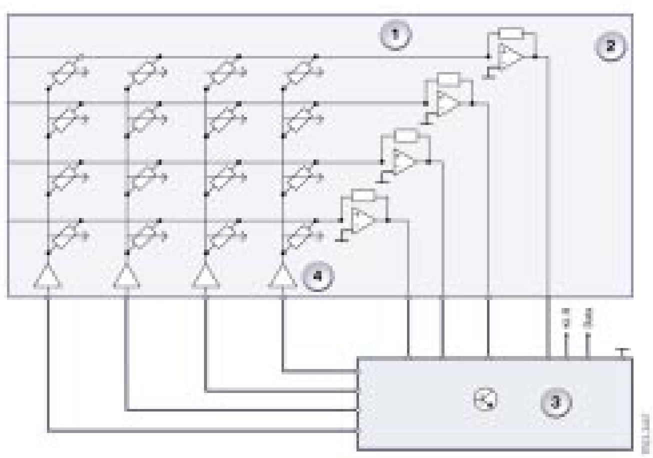
The conductors are connected to the electronic analyzer. The FSR elements are wired in such a way so that they can be sampled individually.

When a mechanical load on a sensor increases, the electrical resistance decreases and the measurement changes accordingly.

By analyzing the signals from the individual sensors, the electronic analyzer maps the occupancy of the seat surface and can identify local concentrations of weight. The distances between the areas and concentrations of weight indicate whether the occupant is small or large. An algorithm is used to compute the weight class and decide whether the seat is occupied by a person or a child seat.

The width between the hip bones is related to the weight of the person. Consequently, the analyzer can distinguish between a light person and a heavy person.

The electronic analyzer sends a telegram to the SBSR via a dedicated signal line. If the occupant is classified as a child in a child seat, the airbags on the passenger side are deactivated. The SBSR sends a telegram to the the SIM via ***byteflight*** and the SIM responds by illuminating the “passenger airbag off” lamp in the center console.



Index	Explanation	Index	Explanation
1	FSR elements	3	Electronic analyzer
2	Output monitoring	4	Input monitoring

Classroom Exercise - Review Questions (E85 ASE)

1. What satellites are used on the E85 ASE system?

2. What component acts as a gateway between the K-Bus and ***byteflight***?

3. What is the voltage of the power reserve of the SIM?

4. In the event of an open circuit of the battery cable monitoring circuit, what voltage would be present at the SBSR?

5. What pyrotechnic devices are triggered by the SBSR?

6. When did the E85 begin to use the OC-3 sensor mat system?

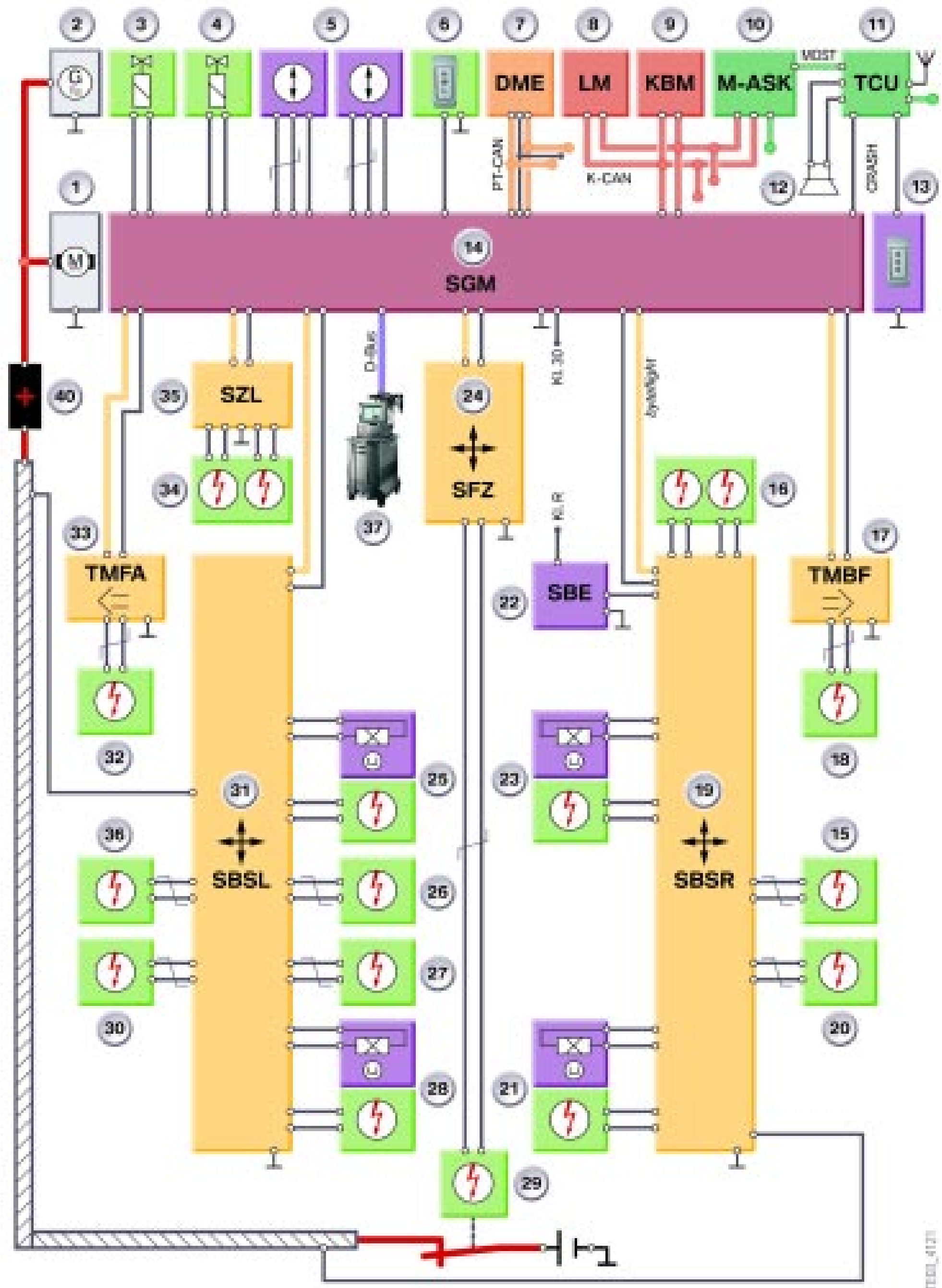
7. Which ***byteflight*** satellite is responsible for the operation of the electric fuel pump on the E85?

8. Which vehicles are equipped with the ASE system?

ASE System Overview (E60)

The ASE system on the E60 is based on the same technology as the E85. However the E60 uses considerably more components than E85. The ASE system has been adapted for use on the E60.

The most notable change in the system (as compared to E85 and ISIS), is the SGM. The SGM has the combined functions for the ZGM and the SIM. This is similar to the E85. Although each of the functions are located in the same housing, the ZGM and SIM have their own diagnostic address.



Index	Explanation	Index	Explanation
1	Starter	21	Seat belt tensioner and buckle switch, Rear right
2	Alternator	22	Seat occupancy detection
3	Servotronic valve (optional)	23	Seat belt tensioner and buckle switch, passenger
4	ECO Valve (AFS only)	24	Vehicle center satellite (SFZ)
5	Upfront sensors, left and right	25	Seat belt tensioner and buckle switch, driver
6	Warning lamp (airbag deactivation)	26	Active headrest, driver
7	DME control unit (ECM)	27	Active headrest, passenger
8	Light module	28	Seat belt tensioner and buckle switch, Rear left
9	General Module (GM5)	29	Battery safety terminal (BST)
10	Multi-audio system controller (M-ASK)	30	Side airbag, rear left
11	Telematic control unit (TCU)	31	B-pillar satellite, left
12	Emergency speaker	32	Side airbag, driver's side
13	Emergency call button	33	Door satellite, front left
14	Safety and Gateway Module	34	Front airbag, driver
15	AITS 2, right	35	Steering column switch cluster (SZL)
16	Front airbag, passenger	36	AITS 2, left
17	Door satellite, front right	37	Diagnosis connection
18	Side airbag, passenger side	40	B+ connection (engine compartment)
19	B-pillar satellite, right	41	B+ cable diagnosis connection (luggage comp)
20	Side airbag , passenger rear	KL30	Terminal 30

The E60 also uses new technology for passenger seat occupancy detection. The new OC-3 (Occupant Classification-3) system can detect the approximate size and weight of a passenger or if a baby seat has been installed.

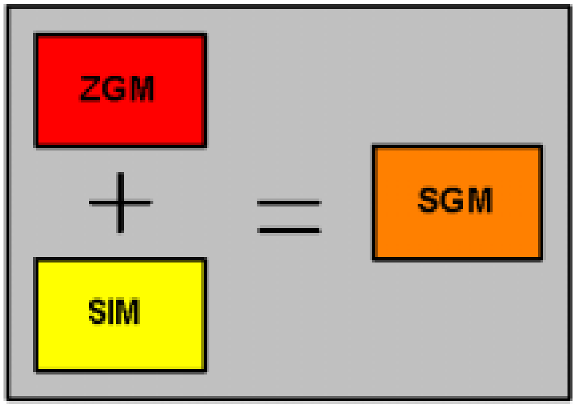
Also, new up-front sensors are used to further fine tune crash detection. They are located behind the front bumper area. These sensors are accelerometers which are capable of detecting acceleration as well as deceleration.

Passive knee protection is also added to the driver and passenger side. It consists of reinforced plastic absorbers on the glove box door and lower steering column areas.

SOS and emergency call capability has also been added. All E60 vehicles will have a TCU installed with GPS capability for location by emergency personnel.

ASE Components E60

Safety and Gateway Module (SGM)

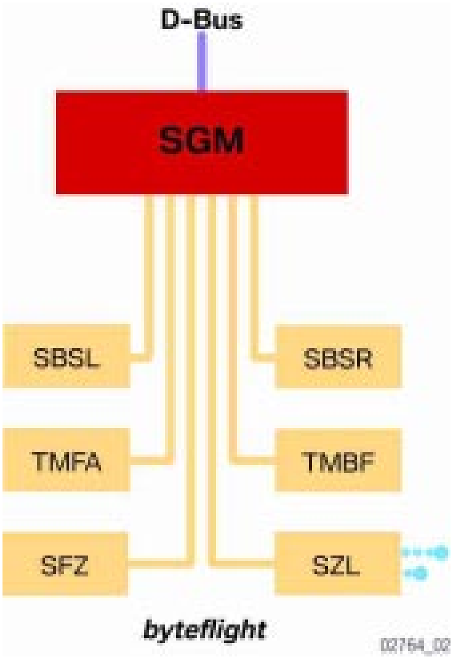


The SGM is a combination of the SIM (E65) and the ZGM (E65). The SGM performs all of the software functions of the ZGM. The functions and hardware of the SIM have been integrated into the SGM with some new functions added.

The SGM is located in the module carrier behind the glove box. There are 2 versions of the SGM used in US models. One uses a purple connector which is for vehicles without AFS or Servotronic. The other has a beige connector and contains the output stages for AFS and Servotronic.

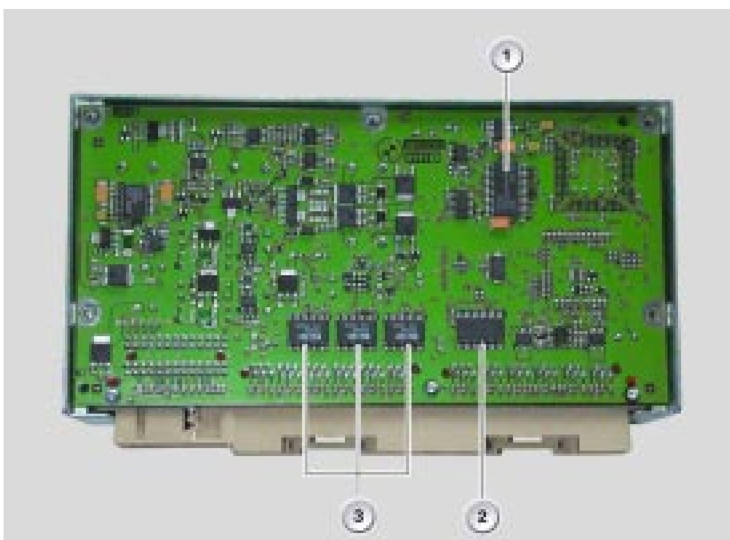
The SGM performs the following functions:

- Provides satellite power supply and reserve voltage (60V) if the power supply should fail during an accident.
- The function of the star coupler and the ***byteflight*** bus main controller (master). The SGM contains 6 S/E modules.
- Acts as a gateway between the ***byteflight***, K-CAN, PT-CAN and D-bus.
- Retains the history memory.
- Provides crash report (telegram) for triggering various functions of other systems.
- Controls and monitors the output stage for the Servotronic valve (optional).
- Controls and monitors the output stage for the ECO valve (optional).



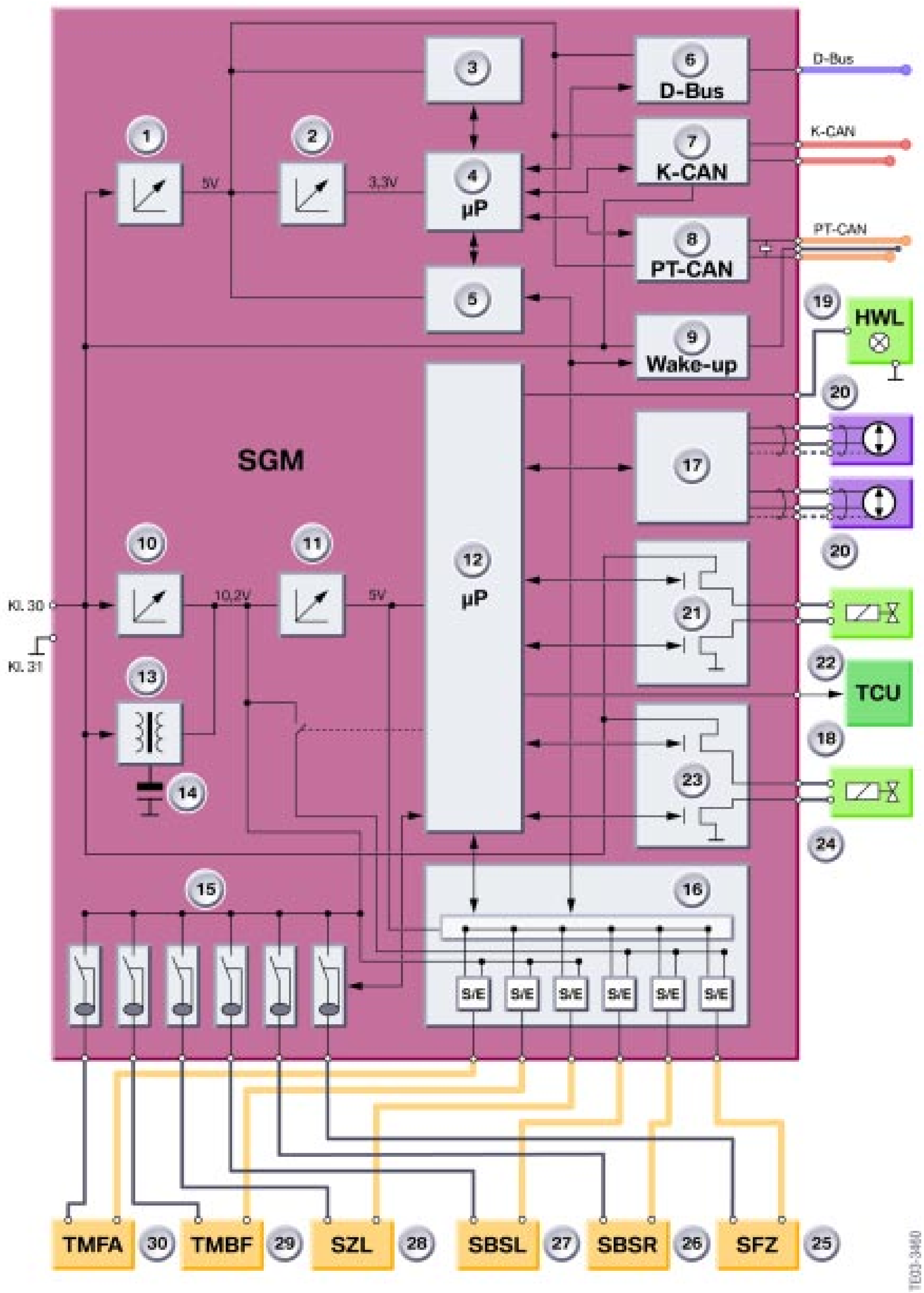
ZGM Internal Components

Index	Explanation	Index	Explanation
1	Microprocessor for ZGM	6	Switching controller
2	Microprocessor for SIM	7	Voltage regulator
3	***byteflight*** controller	8	Transmitter/receiver module
4	Star coupler	9	Output stage for servotronic valve
5	Power reserve	10	Output stage for ECO valve



Index	Explanation
1	RAM (History memory)
2	Interface for the up-front sensors
3	Distributor for satellite power supply

Safety and Gateway Module Schematic



Legend for SGM Schematic

Index	Explanation	Index	Explanation
1	Voltage regulator for interfaces	18	Telematics Control Unit (TCU)
2	Voltage regulator for microprocessor	19	Warning lamp for passenger airbag deactivation
3	History memory (NVRAM)	20	Up-front sensors
4	ZGM microprocessor	21	Output stage for Servotronic valve
5	***byteflight*** controller	22	Servotronic valve
6	Diagnostic bus interface	23	Output stage for ECO valve
7	K-CAN interface	24	ECO Valve
8	PT-CAN interface	25	Vehicle center satellite (SFZ)
9	Wake-up interface	26	B-pillar satellite, right
10	Voltage regulator	27	B-pillar satellite, left
11	Voltage regulator for SIM microprocessor	28	Steering column switch cluster (SZL)
12	SIM microprocessor	29	Door module, passenger door (TMBF)
13	Switching controller for power reserve	30	Door module, driver's door (TMFA)
14	Capacitor for power reserve	KL30	Terminal 30
15	Distributor	KL31	Terminal 31
16	Star coupler	S/E	Transmitter/receiver module
17	Interface for up-front sensors		

Voltage Supply

The SGM is supplied with voltage via KL30 and KL31. A voltage transformer (10.2V) and an intelligent distributor with over current protection carry voltage to the satellites. If a fault occurs, the distributor can shut off the supply to individual satellites.

Power Reserve

At the same time the power reserve is charged. The power reserve consists of a 60 volt capacitor. If the on board supply voltage drops below a defined level, the power reserve is switched on. In this way, the entire functionality of the safety system is maintained for 1 second, which is the time it takes to drain the power reserve.

Note: When performing work on the safety system, always bear in mind that the capacitors will take a few seconds to discharge after the battery has been disconnected. The safety system remains capable of deploying an airbag during this period. Always refer to applicable repair instructions and rigidly observe all safety precautions.

Star Coupler

The star coupler and the 6 S/E modules are powered via a downstream transformer (5V). The same applies for the two microprocessors. The individual fiber optic cables to the satellites are connected to the star coupler. The star coupler emits a synchronization pulse every 250ms. The messages to and from the satellites (bi-directional) are transferred via the ***byteflight*** between these synchronization pulses.

The satellites accommodate acceleration and pressure sensors. These are the sensors that detect a collision. The sensor data is transmitted from the satellites to the star coupler. The star coupler distributes the information to all the satellites. In this way, all the satellites have the same information at their disposal.

The SGM uses the information it receives to recognize the occurrence of a collision. The SGM compares the values with the algorithm in it processor and, if the impact is of sufficient severity, it uses the synchronization pulse to initiate alarm mode.

The alarm mode places the satellites in a triggerable state. The actuators required in any given situation are actuated depending upon the accident severity and the algorithms stored in the satellites.

Gateway

All the functions of the Central Gateway Module in the E65 are integrated into the SGM. The gateway function is responsible for interconnecting the various bus systems in the E60.

The E60 uses the ***byteflight*** bus, K-CAN, PT-CAN, D-Bus and the MOST. The gateway for the MOST is in the M-ASK which is connected to the K-CAN.

The gateway is needed to allow communication across different bus systems. Bus system communication differs in data rate, bandwidth and message structure. Also the gateway allows copper wire bus systems to communicate with optical bus systems.

All connected buses, with the exception of the diagnostic bus, can wake up the gateway. This differs from the E65, in which the wakeup can also be signalled by the diagnostic lead. This is done by a wake up logic which controls the voltage supply of the module. A non-volatile data memory is also integrated in the ZGM which can be used to store configuration and diagnostic data.

As all the systems in the vehicle are networked, the same data can be used for different applications.

Gateway from K-CAN to ASE

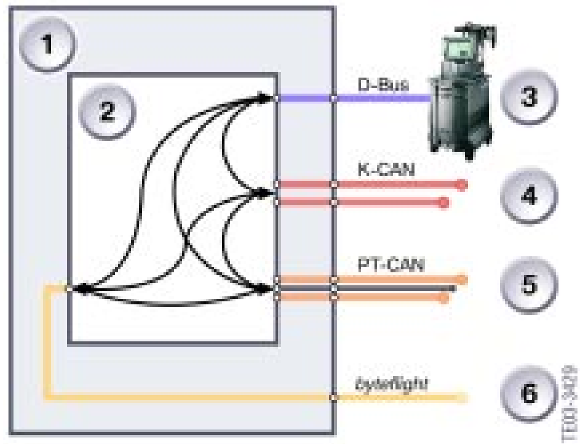
Information and messages from the ASE system are sent from the K-CAN to the SGM as a message. The following messages are sent:

- Terminal status (KL30, 15, R etc)
- Odometer total mileage
- Chassis number (VIN)
- Suspension mode (Sport/Comfort)

Gateway from ASE to K-CAN

Messages and information from the ***byteflight*** which are destined for other equipment attached to the K-CAN bus are converted to a K-CAN message by the gateway function. The following signals are sent as messages:

- Check control messages
- Switch on airbag warning lamp (AWL)
- Open central locking
- Switch on interior and hazard warning lights
- Seat occupancy recognition for SBR function
- Seat-belt status for SBR function



Gateway from the ASE to PT-CAN

- Switch off electric fuel pump
- Switch off generator
- Status of Servotronic valve
- Status of ECO valve for AFS

Gateway from the PT-CAN to the ASE

- Road Speed
- Current input for controlling of servotronic valve
- Current input for controlling of ECO valve

Gateway from the ASE to the MOST via K-CAN

- Send emergency call via the MOST

History Memory

In the E60, the problem of a dead battery due to parasitic current draw is counteracted by various measures. Firstly all consumers that do not need to be permanently connected to the battery are switched off via a relay (KL30g). In addition, the off-load current is constantly monitored by the intelligent battery sensor (IBS).

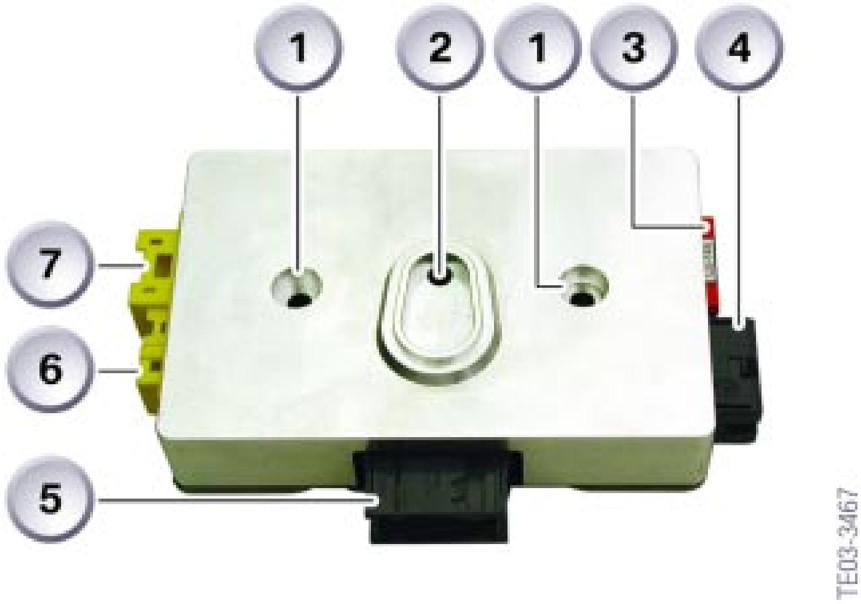
The bus systems are also monitored. A non-volatile memory (NVRAM) is implemented in the SGM so that the following faulty behavior can be logged:

- Which bus has woken up the entire system
- Which bus subscriber (module) prevented the bus system from entering sleep mode following the shutdown of terminal R and the expiration of the run on time (30 min).

Each entry in the history memory identifies the originator and logs the time of day and the odometer reading. In this way, dependable diagnosis can subsequently be performed.

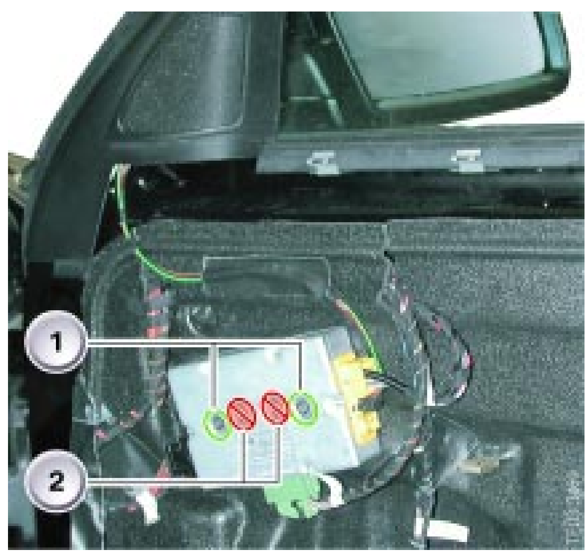
Driver/Passenger Door Module TMFA/TMBF

The driver/passenger door module is a combination of the door module with the body electronics and the front door satellite. The TMFA/TMBF controls and monitors the ignition circuits for the door mounted side airbag. It also detects side-impact collisions using the pressure sensor in the door.



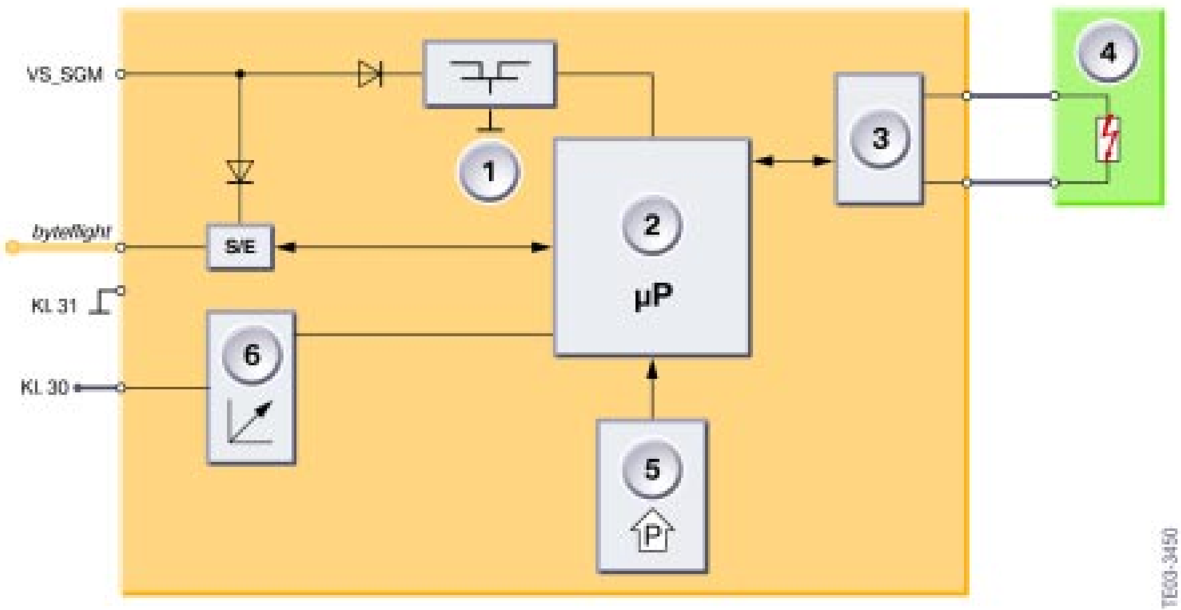
Index	Explanation	Index	Explanation
1	Holes for mounting screws	5	Connector for the input signals
2	Inlet port to pressure sensor	6	Connector for the outside mirrors
3	Connector for switch block	7	Connector for the ASE system ***(byteflight)***
4	Connector for power supply (load current)		

The door module is installed on the inner door panel above the door handle.



Note: When removing the door module it is important that only the two outer screws (1) are loosened. The two inner screws (2) should NOT be loosened. These screws hold the housing of the door module together. Loosening these screws may cause the pressure sensor to operate incorrectly.

TMFA/TMBF Schematic



Index	Explanation
1	Voltage regulator
2	Microprocessor
3	Ignition output stage
4	Igniter pellet for side airbag
5	Pressure sensor
6	Linear controller
VS_SGM	Voltage supply from SGM
KL30	Terminal 30 (B+)
KL31	Terminal 31 (Ground)
S/E	Transmitter/receiver module

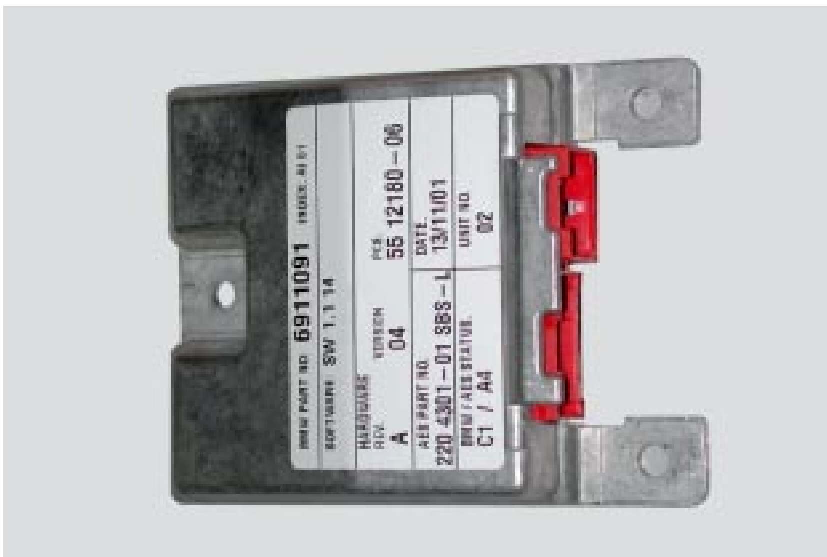
Type of voltage	Voltage	Function
Voltage supply	10.2-10.7 V	Full Function
Voltage supply	10.7-16 V	Restricted function, diagnosis of ignition circuit not possible
Current consumption	typical 90 mA	In normal operation

B-pillar Satellite Left/Right SBSL/SBSR

The left and right b-pillar satellites are connected to the SGM via ***byteflight.*** As on other satellites, the power supply is provided by the SGM and it is buffered by a capacitor. When in sleep mode, the power supply of the satellites is deactivated by the SGM.

Each satellite contains an acceleration sensor for longitudinal acceleration and one for lateral acceleration. The sensors provide a voltage as a measured value. These values are made available on a continuous basis and are transferred to the SGM and other satellites via ***byteflight.***

SBSL/SBSR E60



Type of voltage	Voltage	Function
Voltage supply	10.2-10.7 V	Full Function
Voltage supply	10.7-16 V	Restricted function, diagnosis of ignition circuit not possible
Current consumption	typical 90 mA	In normal operation

When the SGM detects a critical range, the alarm mode is by means of the synchronization pulse. The alarm mode places the satellites in a triggerable state. The trigger matrix stored in the satellites activates the necessary actuators depending upon crash severity.

The trigger circuits of the actuators are connected to the ignition final stages in the satellites and ignited by discharging capacitors.

The self-diagnosis of the trigger circuits during the pre-drive check is the same for all satellites.

Battery cable diagnosis is performed by both satellites. Each satellites forms a portion of the battery cable monitoring circuit. One end of the cable connection is located in the engine compartment and is connected to the SBSL. The other end, which is connected to the SBSR is located in the luggage compartment.

The SBSL controls and monitors the following trigger circuits:

- Head airbag AITS II, left
- Active headrests left and right
- Side airbag, rear left
- Seatbelt tensioner, front left
- Seatbelt tensioner, rear left

The SBSR controls and monitors the following trigger circuits:

- Front airbag, passenger
- Head airbag AITS, right
- Side airbag, rear right
- Seatbelt tensioner, right
- Seatbelt tensioner, rear right

The SBSR also receives input from the passenger seat occupancy detection system. The sensor mat has an electronic evaluation unit (analyzer) that sends seat occupancy information via a dedicated signal line.

The SBSL/SBSR are located low in their respective B-pillars near the seatbelt reel.

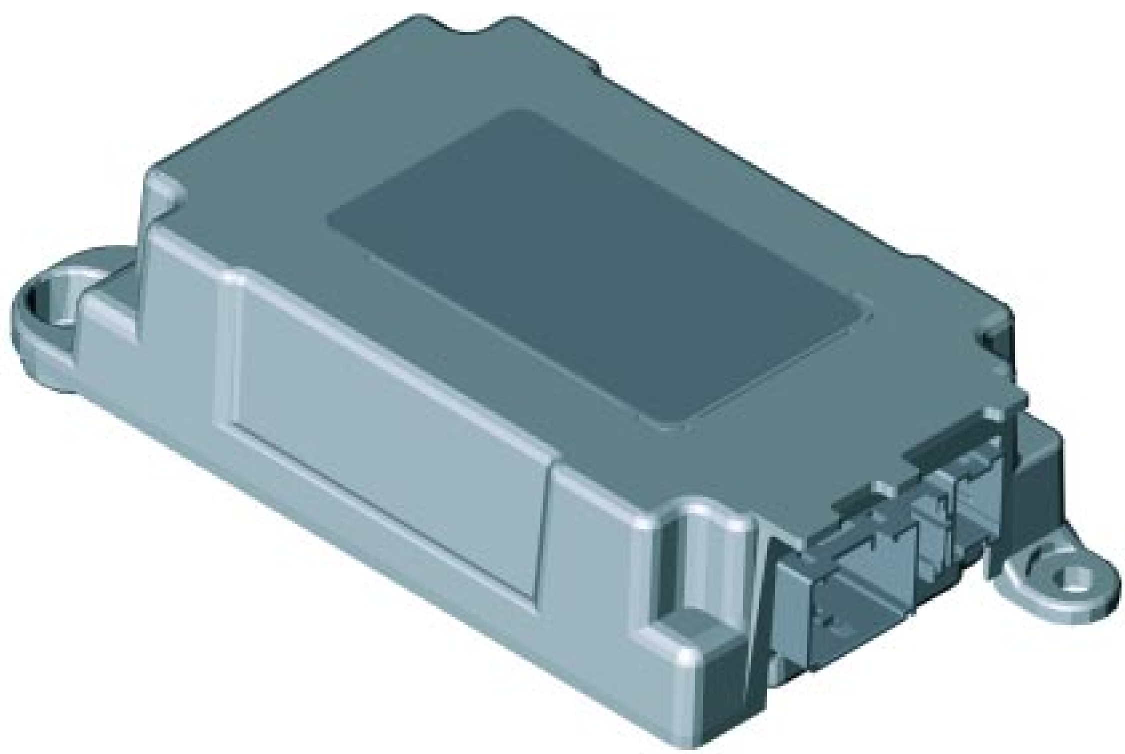
Vehicle Center Satellite

The SFZ controls and monitors the trigger circuit for the BST. It is located on the transmission tunnel and connected to the SGM via ***byteflight***.

As on other satellites, the power supply is provided by the SGM and it is buffered by a capacitor. When in sleep mode, the power supply of the SFZ is deactivated by the SGM.

The SFZ also contains lateral and longitudinal acceleration sensors. These measurements are provided as voltage values and transferred to the SGM and other satellites via ***byteflight***.

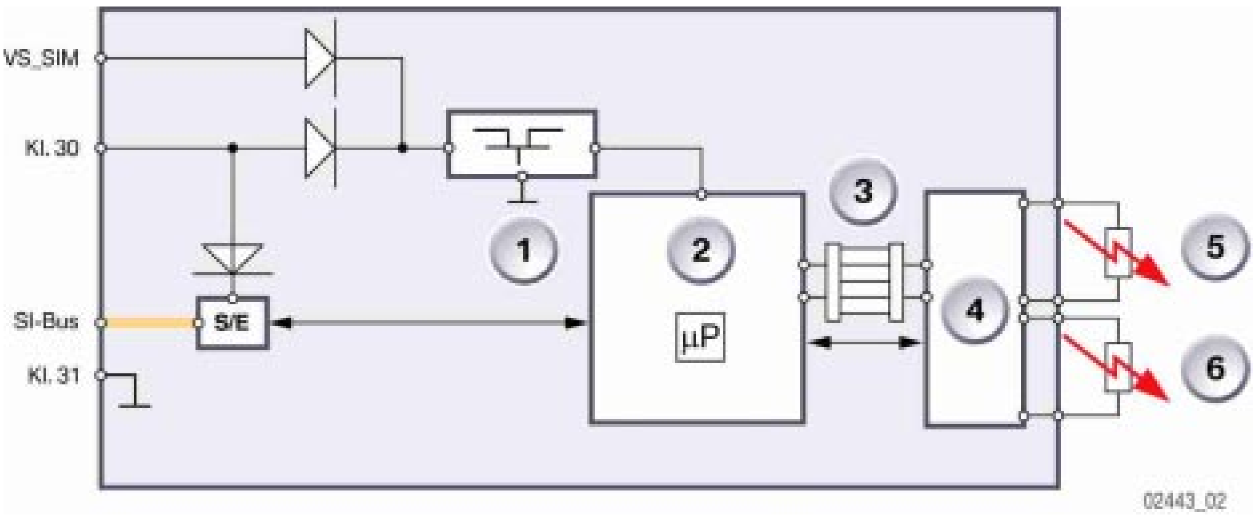
The triggering and monitoring of the trigger circuits are the same for all of the satellites.



Type of voltage	Voltage	Function
Voltage supply	10.2-10.7 V	Full Function
Voltage supply	10.7-16 V	Restricted function, diagnosis of ignition circuit not possible
Current consumption	typical 90 mA	In normal operation

Steering Column Switch Center (SZL)

The SZL consists of two modules, the Steering Column Electronics (LSE) and the Steering Wheel Electronics (LRE). The two components are connected by a clock spring (ribbon cable). The SZL controls and monitors the two trigger circuits for the front airbag on the driver's side (steering wheel).



Index	Explanation
1	Voltage regulator
2	Microprocessor
3	Coil spring
4	Igniter pellet for side airbag
5	Igniter pellet for front airbag 1st stage
6	Igniter pellet for front airbag 2nd stage
VS_SGM (SIM)	Voltage supply from SGM
KL30	Terminal 30 (B+)
KL31	Terminal 31 (Ground)
S/E	Transmitter/receiver module
SI_Bus	***byteflight***

Up-Front Sensors

In the US, seatbelts are not a federal requirement. This legislation is on a state-by-state basis. Therefore, adequate provisions must be made to ensure that the airbag can reliably restrain the occupant in the event of a crash.

The up-front sensors were added to "fine-tune" crash detection. The location of the sensors allow the ASE system to detect frontal impacts earlier. Both sensors are identical for the left and right side.

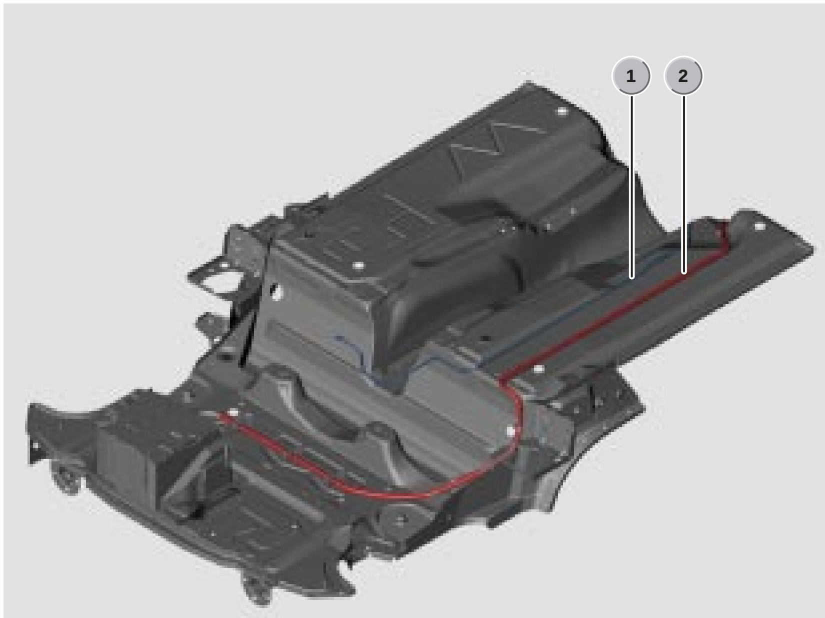
Each sensor consists of a longitudinal acceleration sensor and an electronic evaluation unit for signal processing and data transfer. The acceleration sensor is capable of detecting front as well as rear impacts. The values from the sensors are converted into digital signals and sent to the SGM for analysis.

The up-front sensors are located behind the bumper reinforcement near the engine support arms.

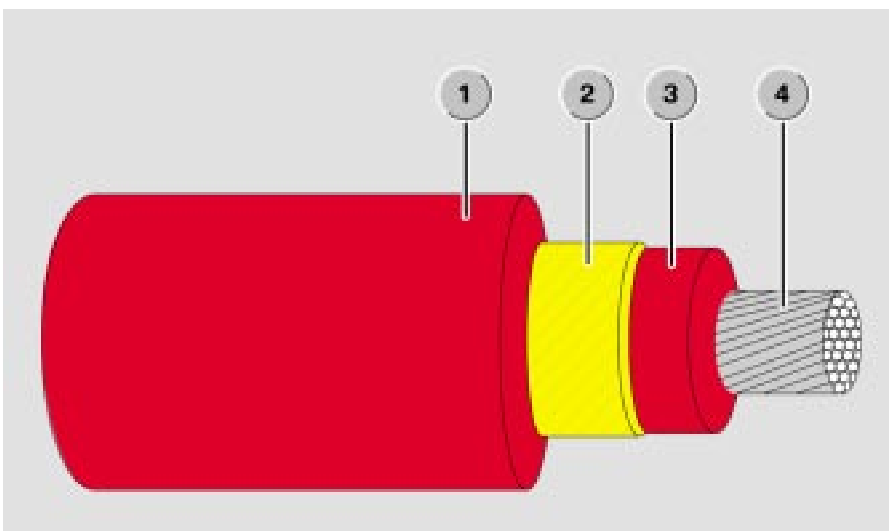
Note: In the event of a crash that triggers the airbags, both up-front sensors must be replaced. Even of no external damage is perceptible, the sensors may be damaged internally. Always refer to and comply with the most current and relevant repair instructions.

B+ Cable Monitoring

The E60 B+ Battery Cable is routed from trunk area along the underside of the car into the engine compartment. If the cable is damaged in an accident or while driving over an obstacle, the BST is activated, protecting the vehicle from further electrical problems.



The battery cable on the E60 is fitted with a low impedance metal mesh. This mesh surrounds the B+ cable insulation and is also covered by an additional insulation. The metal mesh is referred to as the monitoring shield.

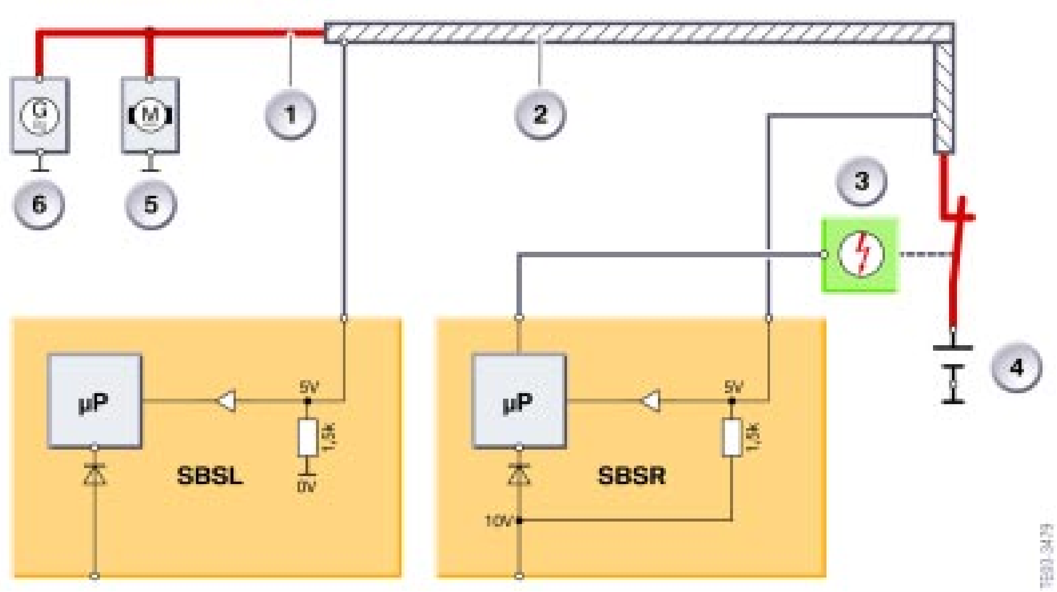


Index	Explanation	Index	Explanation
1	Outer insulation	3	Battery cable insulation
2	Monitoring shield (metal mesh)	4	Battery cable (aluminum conductor 120 mm^2)

Battery Cable Monitoring Circuit

The battery cable is diagnosed by a special circuit between the SBSL and SBSR satellites. The battery cable diagnosis takes place across the low impedance shield of the battery cable (monitoring shield).

There are connections to the left B-pillar satellite and the right B-pillar satellite at both ends of the shield. This means that there is usually the same voltage at the analog/digital converters in the satellites. If the voltages differ, there is a fault.



Index	Explanation	Index	Explanation
1	Battery cable	4	Battery
2	Monitoring shield (metal mesh)	5	Starter
3	Battery Safety Terminal (BST)	6	Alternator

The monitoring shield consists of a low-impedance metal mesh. A connection cable exits from each end of the monitoring shield (at the safety battery terminal in the luggage compartment and at the battery ground point in the engine compartment).

The connection at the safety battery terminal in the luggage compartment is connected to the right B-pillar satellite. The second connection cable in the engine compartment is connected to the left B-pillar satellite.

The satellites contain analog/digital converters that are connected to the microprocessor of the satellite. The connection cables of the battery cable diagnosis are connected to the A/D converters. The right B-pillar satellite contains a pull-up resistor. The left B-pillar satellite contains a pull-down resistor of the same size.

The voltage supply of the satellite (approx. 10 V) is applied at the pull-up resistor. Ground is applied at the pull-down resistor.

The very low-impedance cable and the resistors of the same size mean that around half the voltage (approx. 5 V) is applied at the A/D converters.

In the event of a fault, significantly different measured values would result as follows:

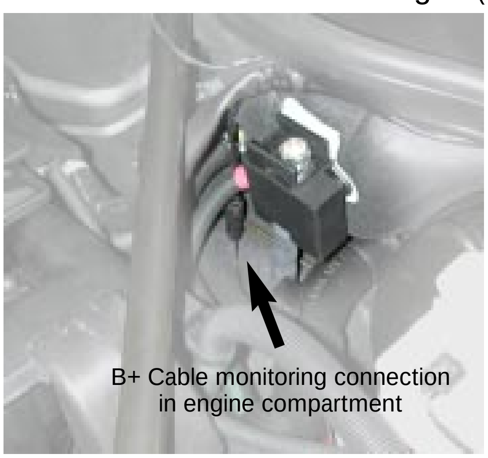
State	Measured value at SBSL	Measured value at SBSR
Battery cable OK	Approximately 5 Volts	Approximately 5 Volts
Interruption (open) of B+ cable diagnosis connection	Approximately 0 Volts	Approximately 10 Volts
Short circuit to ground	Approximately 0 Volts	Approximately 0 Volts
Short circuit to B+ (KL30)	Approximately battery voltage	Approximately battery voltage

Every 250 ms, the values are measured, triggered by the synchronization pulse. If the battery cable is OK, the values are transferred every 20 ms to the SGM. If a significant deviation of the values occurs, the new values are transferred immediately.

In the following cases, the battery cable is cut off by the safety battery terminal from the battery and the alternator is switched off:

- Short circuit to ground (body)
- Short to battery positive

If the outer insulation is damaged (e.g. due to friction/scuffing), but the monitoring shield has no connection to ground, the following case could occur:



Battery cable with monitoring connection
(note - BST side of cable)

1. Monitoring connection 2. Battery cable

Moisture (rain) would mean that the voltage would gradually fall. A short circuit to ground would be detected, but the safety battery terminal would not be triggered.

The entry "Implausible measured value" is set in the fault code memory. This would be indicated to the driver by the airbag warning lamp.

Battery Cable Diagnosis

If the shielding of the battery cable is damaged, the battery cable must be replaced completely. It is not permitted to perform repairs to the shielding.

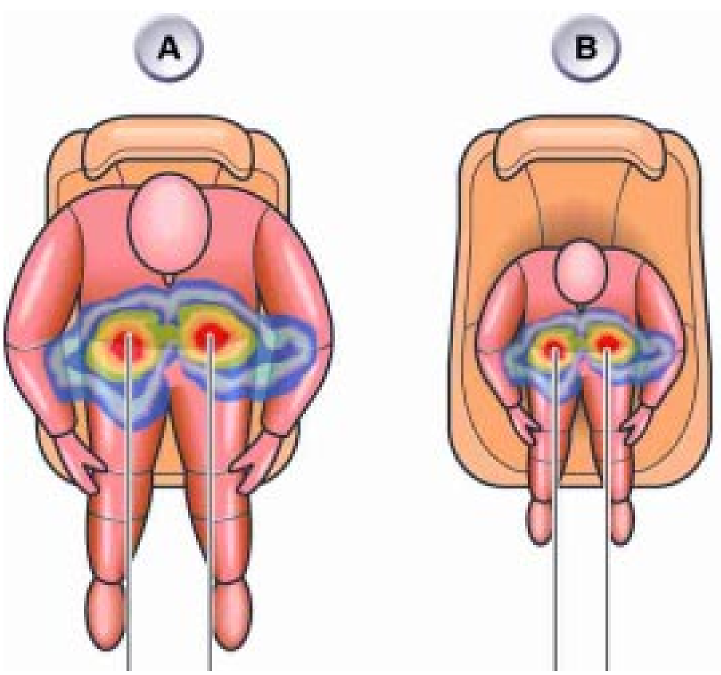
Passenger Seat Occupancy Detection (OC-3)

The new occupancy detection system is a further enhancement of the the existing SBE system. Current governmental safety regulations make it necessary for the passive safety system to be able to determine the approximate size and weight of the passenger. This enables the system to deactivate the passenger side airbag when traveling with a child or an infant ina child seat.

To accomplish this, the existing SBE system was subsequently developed into the new "intelligent occupant classifier" (**O**ccupant **C**lassification) or OC-3 system. This was achieved by:

- Adding a larger number of "force sensitive" resistance elements.
- Dividing the detection mat into zones which cover the entire seat area.
- Using an intelligent electronic analyzer.

The OC-3 sensor mat is capable of distinguishing between a one-year old child in a child seat and a light person. This is done by analyzing the distribution of weight across the seat. For example, a child in a child seat would be distinguished from a 90 pound adult by the contact pattern. In other words, the contact pattern of a child seat would differ considerably from an adult due to the spacing of the hip bones vs. the child seat "rails".



The OC-3 sensor mat is integrated into the lower seat pad area of the passenger seat. The mat consists of conductors with pressure-dependent resistor elements also known as FSR (Force Sensitive Resistance) elements.

The conductors are connected to the electronic analyzer. The FSR elements are wired in such a way so that they can be sampled individually.

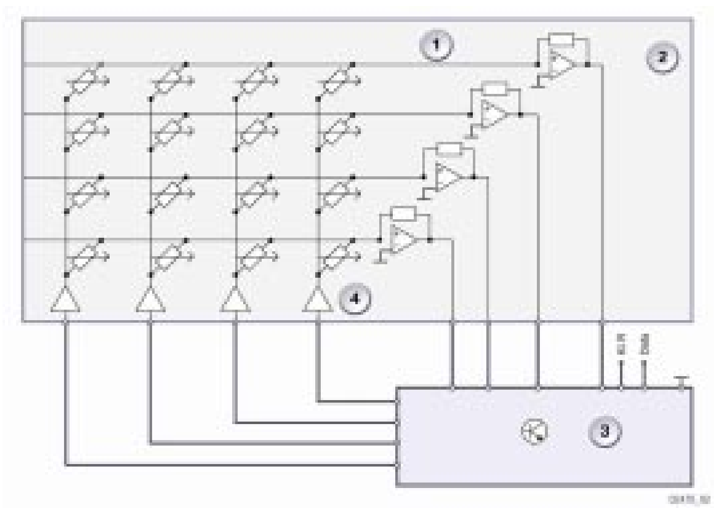
When a mechanical load on a sensor increases, the electrical resistance decreases and the measurement changes accordingly.

OC-3 Sensor Mat **Conventional Sensor Mat**

By analyzing the signals from the individual sensors, the electronic analyzer maps the occupancy of the seat surface and can identify local concentrations of weight. The distances between the areas and concentrations of weight indicate whether the occupant is small or large. An algorithm is used to compute the weight class and decide whether the seat is occupied by a person or a child seat.

The width between the hip bones is related to the weight of the person. Consequently, the analyzer can distinguish between a light person and a heavy person.

OC-3 Sensor Mat Schematic



Index	Explanation	Index	Explanation
1	FSR elements	3	Electronic analyzer
2	Output monitoring	4	Input monitoring

The electronic analyzer sends a telegram to the SBSR via a dedicated signal line. If the occupant is classified as a child in a child seat, the airbags on the passenger side are deactivated. The SBSR sends a telegram to the the SGM via ***byteflight*** and the SGM responds by illuminating the “passenger airbag off” lamp in the overhead panel.

Airbag Indicator Lamp

The "passenger airbag off" indicator light is located in the front overhead console. This light is controlled via a PWM signal from the SGM based on data from the OC-3 system.

The lamp contains 2 LED's for redundancy. If one LED fails, a fault code will be stored in the SGM and the AWL will be illuminated.

Index	Explanation	Index	Explanation
1	Hands free microphone, left	4	Emergency call button
2	Sunroof switch	5	Hands free microphone, right
3	Airbag indicator lamp		

Service Information (E60)

Passenger Airbag Module

If the passenger airbag module is triggered, the supporting tube has to be checked. The forces to which it is exposed are high, and the possibility of the supporting tube deforming cannot be excluded. Consequently, the supporting tube has to be checked and, if necessary, replaced.

Battery Cable Diagnosis

If the shielding of the battery cable is damaged, the battery cable must be replaced completely. It is not permitted to repair the shielding.

Safety Battery Terminal

If the safety battery terminal is triggered, the battery cable has to be replaced all the way back to the main adapter point in the luggage compartment. Repair is not intended.

Door Module, Driver's Door/Passenger Door

When removing the door module, it is essential to ensure that the two inner screws (2) of the door module are not removed. These screws hold the housing of the door module together and ensure that the pressure sensor is sealed. If the screws are slackened there is a possibility that the pressure sensor will no longer operate correctly.

Up-Front Sensors

In the event of a crash that triggers the airbags, the up-front sensors have to be replaced. The sensors might be damaged internally, even though no external damage is perceptible. Always comply with the instructions in the repair manual when replacing the up-front sensors.

Synchronization of New Modules

When new satellite modules are fitted, these modules have no system time. Transmission of the two system time telegrams allows the module to adapt the system time. This is only possible when the stored system time in the satellite modules is smaller than the time sent.

If the system time in a module is greater than the time sent, (Ex. trying a part from another vehicle), the system time is not adopted and an entry is made into fault memory.

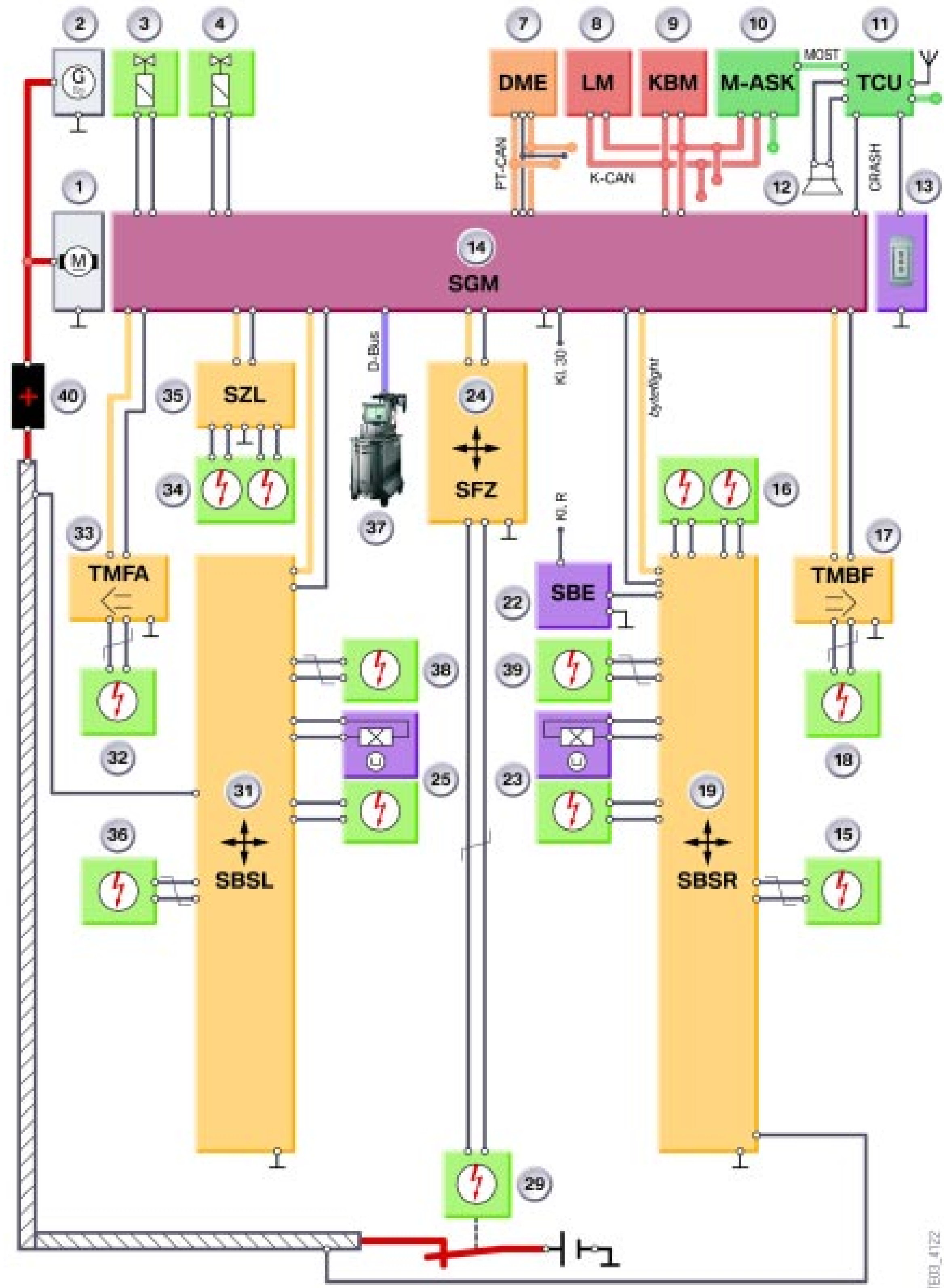
When the SIM or any satellite is replaced, the system time must be entered. As the system time is available in all ASE modules, it can be transferred into the new module.

This takes place via the Diagnosis Program (Service Functions). To do so, the DISplus /GT1, requests the system time from all satellites and selects the largest.

The DISplus/GT1 add an amount to this time and transmits the result into the new module as the system time. The correction amount compensates for the run time between reading from the satellites and entry into the new module.

This prevents fault messages from the satellites because the system time transferred by the new module is smaller than that stored in the satellites.

ASE System Overview (E63)



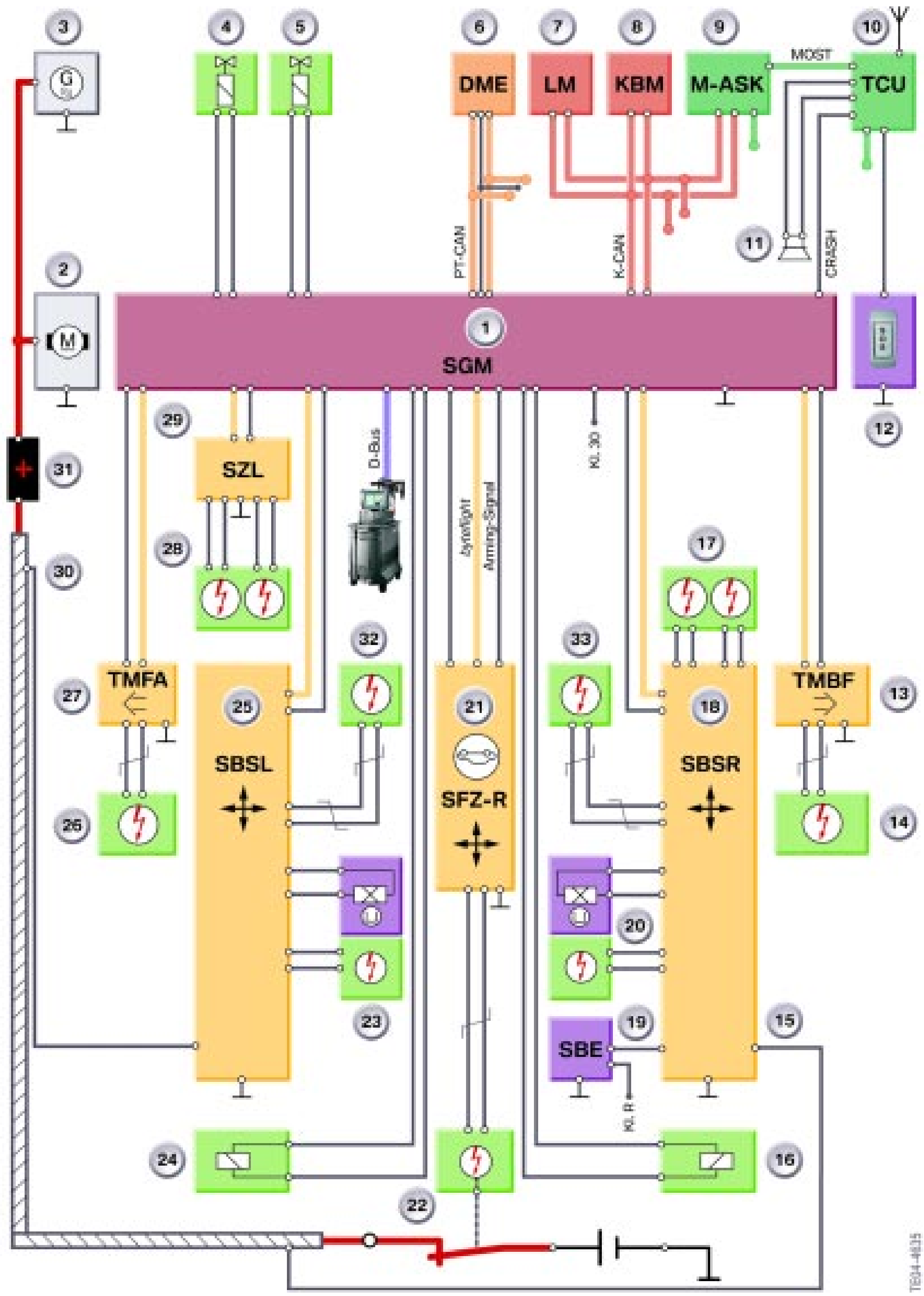
Legend for System Overview (E63)

Index	Explanation	Index	Explanation
1	Starter	23	Seat belt tensioner and buckle switch, passenger
2	Alternator	24	Vehicle center satellite (SFZ)
3	Servotronic valve (optional)	25	Seat belt tensioner and buckle switch, driver
4	ECO Valve (AFS only)	29	Battery safety terminal (BST)
7	DME control unit (ECM)	31	B-pillar satellite, left
8	Light module	32	Side airbag, driver's side
9	General Module (GM5)	33	Door satellite, front left
10	Multi-audio system controller (M-ASK)	34	Front airbag, driver
11	Telematic control unit (TCU)	35	Steering column switch cluster (SZL)
12	Emergency speaker	36	AITS 2, left
13	Emergency call button	37	Diagnosis connection
14	Safety and Gateway Module	38	Knee Airbag, driver
15	AITS 2, right	39	Knee airbag, passenger
16	Front airbag, passenger	40	B+ connection (engine compartment)
17	Door satellite, front right	41	B+ cable diagnosis connection (luggage comp)
18	Side airbag, passenger side	KLR	Terminal R
19	B-pillar satellite, right	KL30	Terminal 30
22	Seat occupancy detection		

The ASE system used on the E63 contains all of the feature from the E60 with the following changes/additions:

- The addition of front driver and passenger knee airbags (active knee protection).
- AITS I head airbag is used
- B-pillar satellites have been modified for use in the E64.

ASE System Overview (E64)



Legend for ASE System Overview (E64)

Index	Explanation	Index	Explanation
1	Safety and Gateway Module (SGM)	19	Seat occupancy detection
2	Starter	20	Seat belt tensioner and buckle switch, passenger
3	Alternator	21	Vehicle center satellite (SFZ-R) with URSS
4	ECO Valve (AFS only)	22	Battery safety terminal (BST)
5	Servotronic valve (optional)	23	Seat belt tensioner and buckle switch, driver
6	DME (ECM)	24	Rollover protection system, left
7	Light Module	25	B-pillar satellite, left
8	Body Base Module (KBM)	26	Side airbag, driver's side
9	Multi-audio system controller (M-ASK)	27	Door satellite, front left
10	Telematic control unit (TCU)	28	Front airbag, driver
11	Emergency speaker	29	Steering column switch cluster (SZL)
12	Emergency call button	30	B+ Cable monitor connection (Engine comp)
13	Door module, passenger door	31	B+ cable junction point (engine compartment)
14	Side airbag, passenger side	32	Knee airbag, driver
15	B+ Cable monitor connection (luggage)	33	Knee airbag, passenger
16	Rollover protection system, right	KLR	Terminal R
17	Front airbag, passenger	KL30	Terminal 30
18	B-pillar satellite, right		

The ASE system used on the E64 contains all of the features from the E60/E63 with the following changes/additions:

- No AITS
- Rollover Protection System added
- Seat Integrated Belt System Installed (SGS)
- SFZ modified with rollover sensor (SFZ-R)
- Updated SGM to include actuator circuits for RPS rollover bars.

Workshop Exercise

Using an instructor designated vehicle, access the electronic analyzer of the OC-3 system under the front passenger seat. Using the oscilloscope functions of the DISplus/GT-1, measure the signal from the electronic analyzer to the SBSR.

List the connector/pin/wire color: ______________________________

Describe the scope pattern and record scope settings below:

____

____

____

Place object or sit on seat and observe changes to scope pattern.

Describe changes to scope pattern:

____

____

____

Perform short test on complete vehicle, then access the status pages for the OC-3 sensor mat:

Where are the status pages found?

____

____

Using the appropriate fused jumper, ground the data line from the seat occupancy system to the SGM.

What is observed regarding the status of the following?

Fault Codes:

____

____

Status of "Passenger Airbag OFF" light:

____

____

Status requests pages:

____

____

Workshop Exercise

Unplug the "Passenger Airbag OFF" light in the overhead console and perform the appropriate test module to diagnose that circuit.

What is the specified voltage for the lamp circuit in the test module?

Measure the voltage on both sides of the lamp circuit using the oscilloscope.

Record observations and scope settings below:

What test cable is used to test the lamp circuit?

What module controls the lamp circuit?

Notes:

Classroom Exercise - Review Questions

1. What component on the E60 ASE system has the responsibilities of the ZGM and SIM used on the E65?

2. What is the difference between Active Knee Protection and Passive Knee protection?

3. What is unique about the door modules (TMFA/TMBF) on the E60 as compared to the E65 door modules?

4. What ***byteflight*** component is responsible for the operation of the fuel pump?

5. What pyrotechnic devices are triggered by the SFZ?

6. Under what circumstances are the up-front sensors to be replaced?

Classroom Exercise - Review Questions

7. In the E64 where are the "sensing" electronics for rollover protection located?

8. What is different about the seats in the E64?

9. What is the difference between the sensor mat used on the previous passenger seat occupancy detection system and the OC-3 system?

10. What component is responsible for triggering the "Passenger Airbag OFF' warning light?

Notes:

Passive Safety Components

The following represents the passive safety components specific to to the vehicles using "***byteflight*** based" passive safety systems including E65, E66, E60, E63, E64 and E85. Model specific components will be pointed out where applicable.

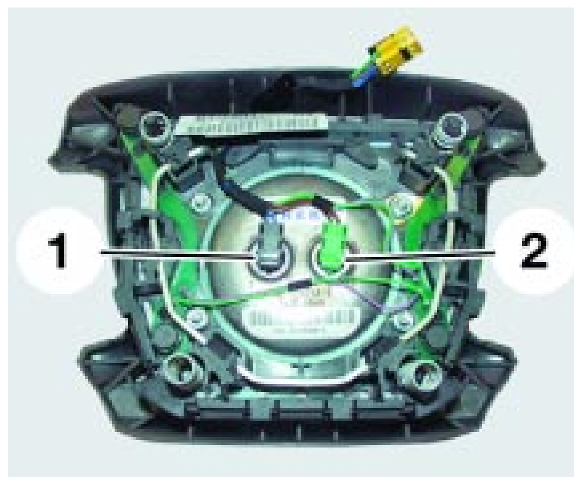
Driver Front Airbag

Two-stage "SMART" airbags have been available on BMW models since the 1999 model year.

Depending upon the level of crash severity, both ignition stages are activated at timed intervals. The time difference between ignition intervals determines the deployment force of the airbag.

E65 Driver's side airbag, front view

E65 Driver's side airbag, rear view



1. Ignition stage 1 2. Ignition stage 2

Driver's airbags are available in the standard or sport configuration depending upon optional equipment. Some airbags are available color matched to the interior. Colors include black, beige, grey or blue.

These new style airbags use are "clipped" in rather than using screw type fasteners. Refer to the relevant repair instructions for removal and installation.

WARNING!!!

When storing an airbag during repair procedures always place airbag with the BMW emblem facing up. This reduces the danger in the event of a spontaneous deployment.

E60 Driver's side airbag, front/rear view

1. Ignition stage 1 2. Ignition stage 2

Passenger Front Airbag

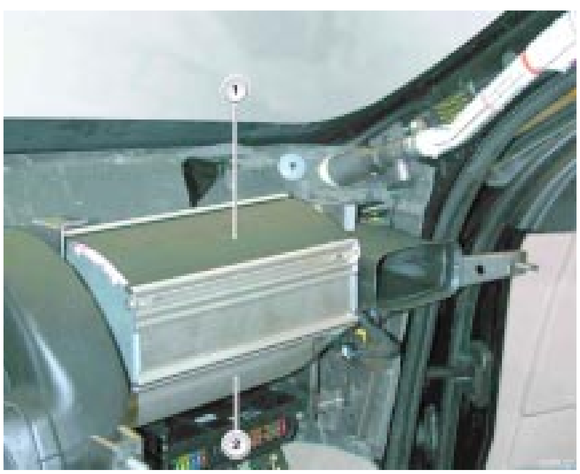
The passenger airbag also uses the 2-stage deployment technology. It uses a hybrid method for ignition using a combination of solid fuel and inert gas. The passenger airbag on the newer vehicles (E6X) no longer uses a separate cover on the dash panel. The dash panel has internal perforation that is designed to tear at pre-determined points.

E65 Dash Panel, passenger side

E65 airbag, passenger side

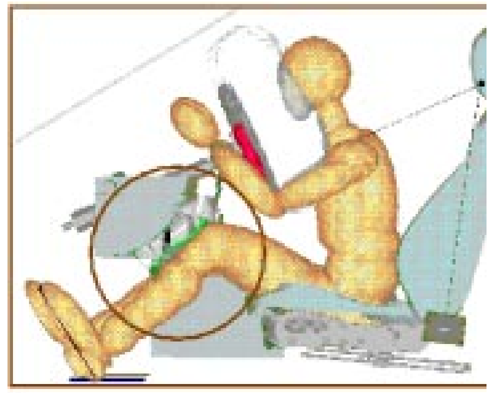
This method prevents the airbag from being deflected in the event that the panel does not swing out of the way properly.

E60 passenger side airbag, without dash panel installed.



E85 passenger side airbag

Knee Airbags



Introduced on the E65, the knee airbag is a new innovation for BMW models. The knee airbags are installed on the driver and passenger side.

In the event of a crash, the knee airbags not only support the knee, but initiate a controlled forward shift of the upper body. This controlled shift places the upper body in the correct location to allow proper contact with the airbag.

The driver's side knee airbag is installed in the under dash trim, right below the steering column. The passenger side knee airbag is part of the glovebox lid.

The knee airbag ignition circuit consists of only one stage. Knee airbags are currently available on the E65, E66, E63, E64 and E85.

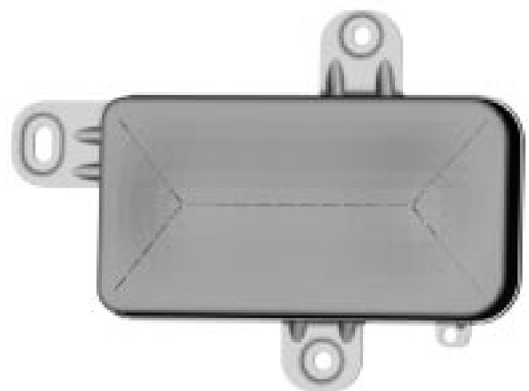
Side Airbags

The side airbags in the doors reduce the risk of occupant injury in the torso region of the body in the case of a side-on crash. The side airbags are folded into an aluminum housing with a plastic cover behind the door trim. In the area of the side airbag in the door trim is a tear seam.

The side airbags are secured to the inner door panel with 3 screws. The plastic cover has defined breaking points.

In a side impact of sufficient severity, the side airbag is triggered. The side airbag exits through the split line and deploys between the door and the seat occupants.

Side airbag on door panel , E65



Side airbag, typical

Head Protection Systems

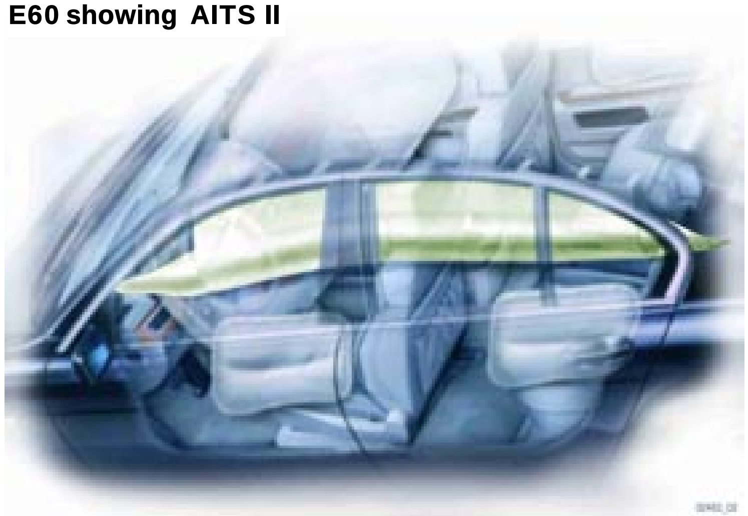
New for the E65 is the Advanced Head Protection System (AHPS) which is an extended head airbag. The ITS Inflatable Tubular Structure familiar from other BMW models has been extended by a curtain.

The E60 and E63 have adopted a similar design referred to as Advanced Inflatable Tubular Structure (AITS).

There are two versions of the AHPS (or AITS).

The Advanced HPS I (or AITS I) is for the head area of the driver and passenger. It runs from the A-pillar to behind the B-pillar, as before. The volume is approx. 12 liters.

E60 showing AITS II



When rear airbags are ordered as an option, there is the Advanced HPS II (AITS II)for the head area at the front and rear. The AHPS II runs from the A-pillar to the C-pillar and covers the entire side section. The volume is approx. 24 liters.

In conjunction with the side airbags in the front and rear doors, it provides optimum side protection for all passengers. The Advanced HPS prevents the head and other extremities of the occupants from swinging outward. This leads to less severe neck backlash forces and less severe head injuries.

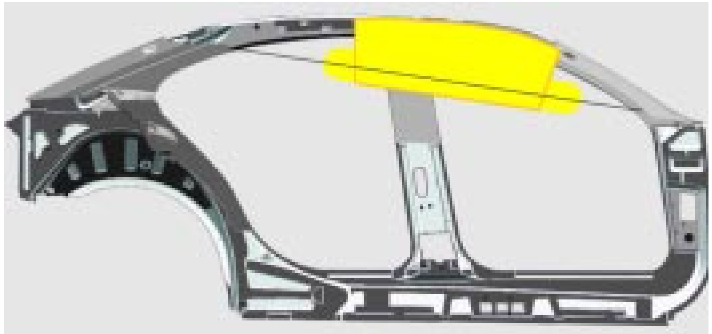
Advantages of the system:

- Extended coverage area for side windows front and rear.
- Protection against glass splinters and penetrating objects.
- Improved protection area for any size occupants.

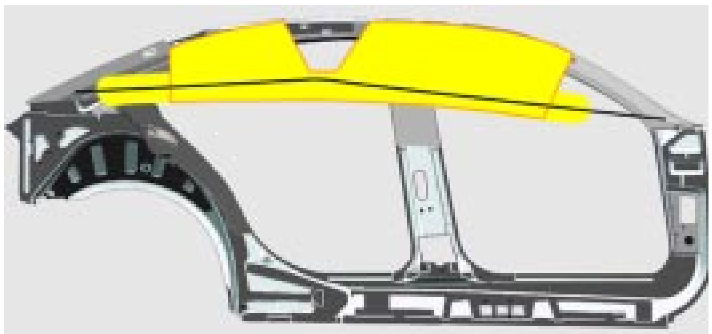
E60 AITS

Index	Explanation
1	Gas Generator
2	Igniter Pellet
3	Retainer Strap

AHPS I



AHPS II



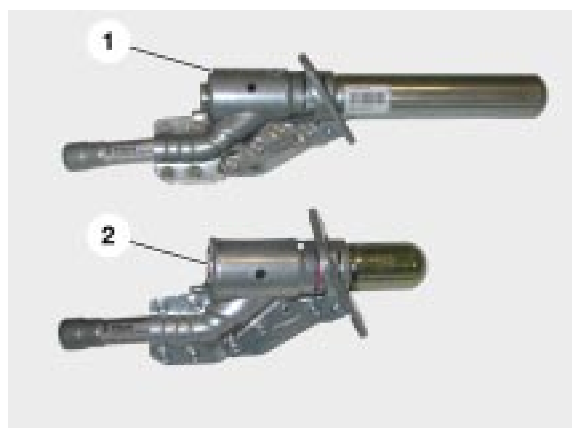
Operation

The Advanced HPS is fitted in the roof zone. It consists of a woven tube with an additional curtain wrapped around it. The curtain is secured to the roof frame and is tensioned downward by the woven tube.

In the event of a side collision, the generator is ignited and the gas flows through the gas injector into the woven tube. The woven tube expands to approx. 130 mm in diameter and its length is reduced.

Secure fitting of the woven tube on the A-pillar and the C-pillar HPS II or on the roof frame (AHPS I) brings the head airbag into position. In the process, the curtain tightens between the side window or pillar trim and the occupant.

The high tensioning force in the woven tube pulls the curtain downward, which increases the stability of the curtain. The closed system means that the structural firmness and stability remain for several seconds. This is an advantage if the vehicle rolls over.



1. Gas generator for AHPS II
2. Gas generator for AHPS I

Active Head Restraint System

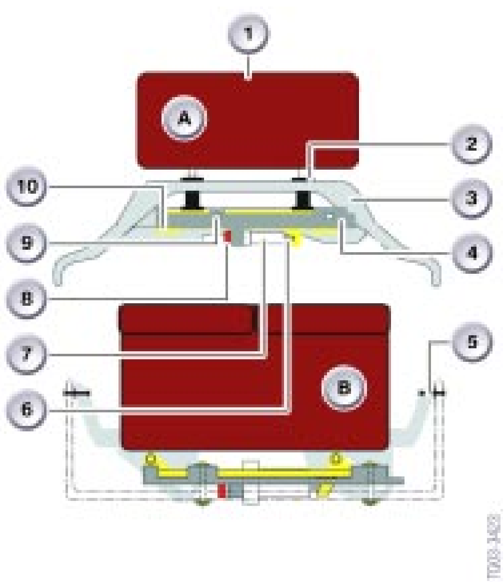
One of the innovations introduced on the E65 was the AKS or Active Head Restraint System. The AKS has also been added to the E60 as well.

AKS is only used on the multifunction (comfort) seat. The basic seat does not need the AKS due to the fact that the position of the occupants head is always in close proximity to the headrest. The comfort seat has an articulated upper backrest which can create a sizeable distance between the head of the occupant and the headrest.

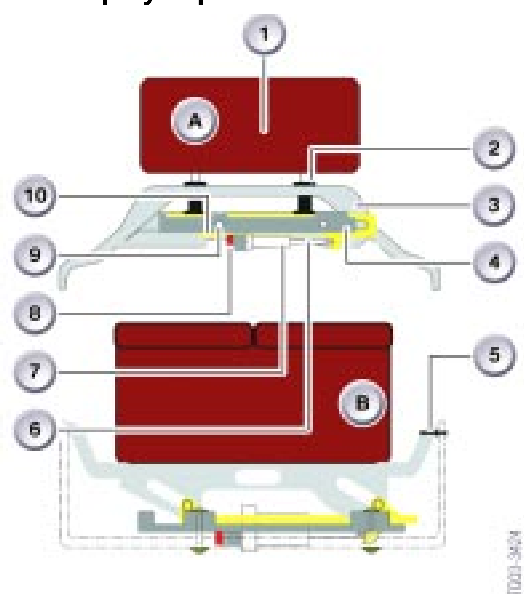
In a rear collision, the torso of the occupant is accelerated with the vehicle. However the head, which is not on constant contact with the seat, is susceptible to high g-forces which can lead to cervical vertebrae injuries (whiplash).

For this reason, the AKS is designed to reduce the gap between the head restraint and the head to reduce the possibility of whiplash.

AKS in primed position



AKS in deployed position

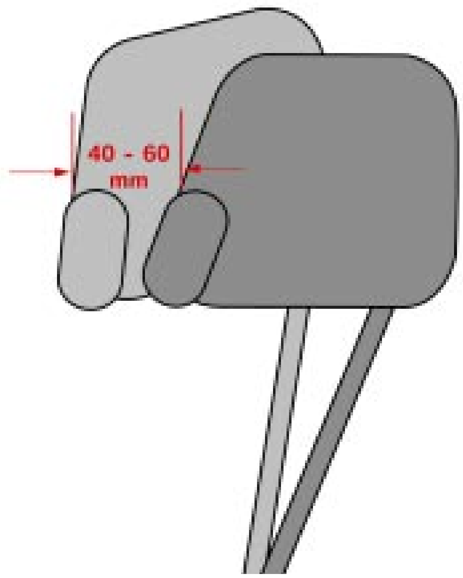


Index	Explanation	Index	Explanation
A	Rear View	5	Center of Rotation
B	Top View	6	Piston Rod
1	Headrest	7	Alternator
2	Headrest Guide	8	Igniter pellet with connection
3	Support Tube	9	Mounting points
4	Retaining Plate	10	Sliding element

The active head restraint system is located in the backrest of the comfort seat. The AKS consists of a support tube, which is fitted on bearings in the backrest. A retaining plate attaches the system firmly to the backrest.

The support tube serves as a fixture for the head restraint. The adjustment mechanism of the head restraint is also attached to the support tube.

The adjustment mechanism consists of a retaining plate and a sliding element. The sliding element is a moveable part connected to the gate located on the support tube. The retaining plate is firmly attached to the backrest. The generator is located between the retaining plate and the sliding element.



The generator consists of a casing, plunger, ignition stages and an electrical connection. It is attached to the retaining plate and sliding element by spring clips.

In the event of a crash, the ignition stage is activated, the solid fuel burns and the gas produced forces out the push rod. The push rod moves out and shifts the sliding element.

The support tube is pivoted forwards because of the slanted, elongated holes in the support tube which the sliding element rides in.

This means that the head restraint attached to the support tube is also moved in the direction of travel. The adjustment range of the headrest is approx. 9 degrees.

Depending on the vertical adjustment of the head restraint at the time, different adjusting distances can result. The adjustment of the head restraint, measured on the cushion, is approx. 40 mm when the head restraint is retracted (all the way down).

When the head restraint is fully extended (all the way up), the adjustment is approx. 60 mm.

If the Active Head restraint has been triggered in a crash, only the gas generator needs to be replaced to return the system to normal function.

Battery Safety Terminal (BST)

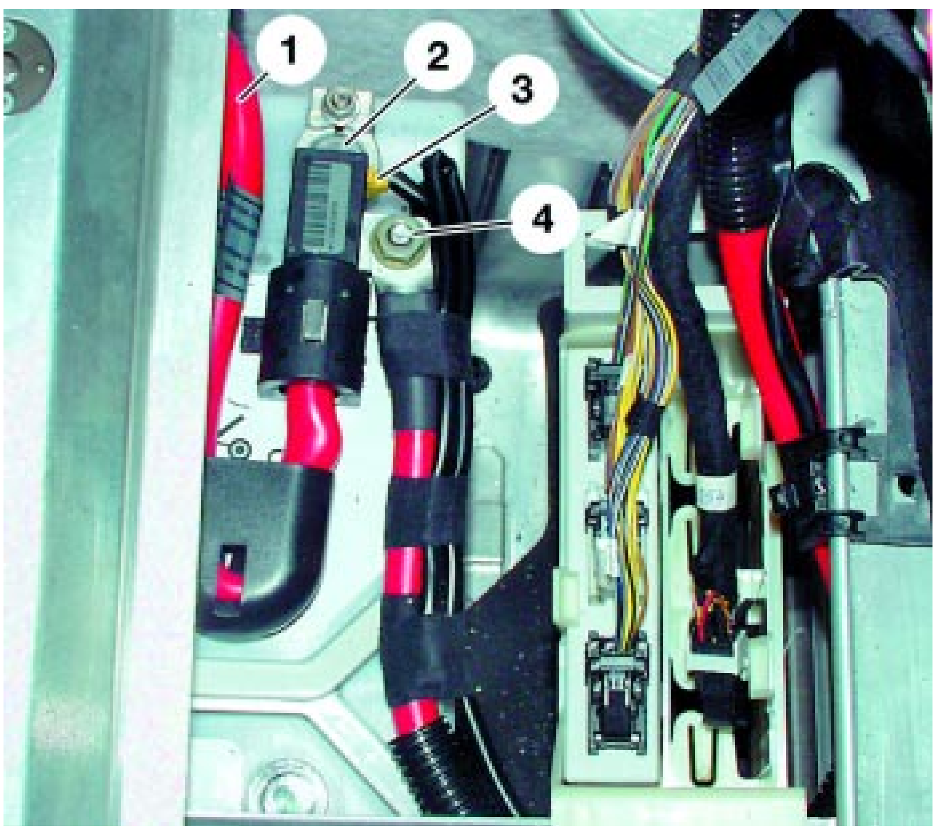
The Battery Safety Terminal (BST) is technically identical to the one used in MRS systems. BST is used on all current BMW models including all E6X models.

If the ISIS system detects a crash of sufficient severity, the ignition stage of the BST is triggered by the B-pillar satellite, right (SBSR).

A small quantity of solid fuel electrically and mechanically cuts the starter and alternator line from the positive terminal of the battery. This prevents possible short circuits in the engine compartment.

A separate vehicle electrical system connection through the Power Module ensures that the remaining vehicle circuit retains its function when the BST is triggered.

This ensures the operation of all the important functions such as lights, hazard warning lights, telephone emergency call, etc.



Index	Explanation
1	B+ battery cable
2	B+ Terminal
3	BST connection
4	B+ cable connection to power distribution

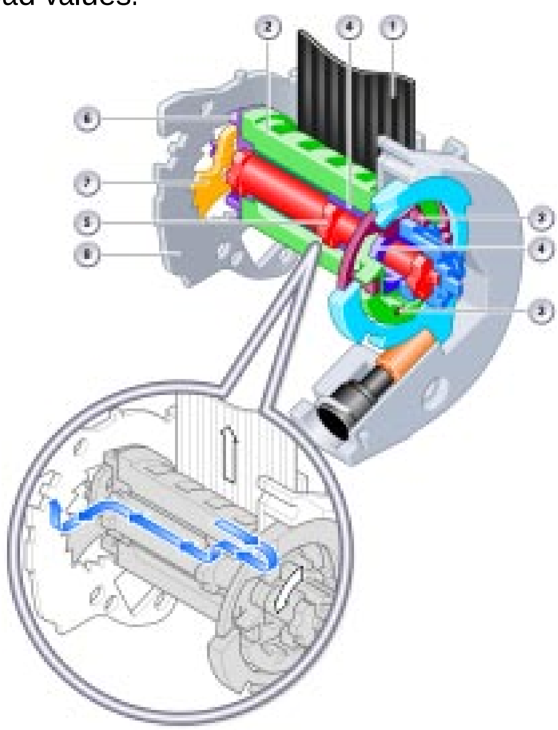
Belt Tensioning Systems

Front Belt Tension Limiter (E65/E66)

The belt tension limiters for the driver and passenger seat are inertia reel seatbelts with adaptive force limitation.

A gas generator is used to switch from a high degree of force to a lower degree of force. This also has to be possible during an accident to achieve a regressive force reduction. The advantage of the adaptive belt tension limiter is the considerable reduction of the load on the chest in the event of a crash.

With optimum coordination to the airbag, the kinetic energy of the occupant is reduced evenly across the duration of the crash, thus achieving low occupant load values.



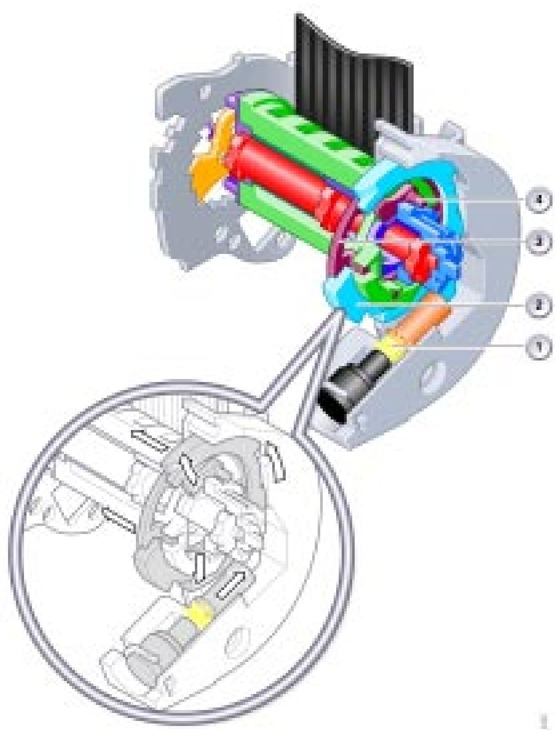
Index	Explanation	Index	Explanation
1	Seat belt webbing	5	Sleeve
2	Belt roller	6	Locking pawls
3	Connecting sleeve	7	Housing
4	Torsion bar		

Operation

The adaptive force limitation is based on a two-stage torsion bar (stage shaft). The torsion bar consists of the two head ends left and right, the stages and the center head. The belt force is transferred to the seatbelt roller. The seatbelt roller is connected to a sleeve that contains the torsion bar. There is a shaft ring with locking pawls on the sleeve. The locking pawls transfer the torque to the torsion bar.

In the first stage, with the preset high level of force, the torque of the seatbelt roller is transferred via the locking pawls to the center head of the torsion bar.

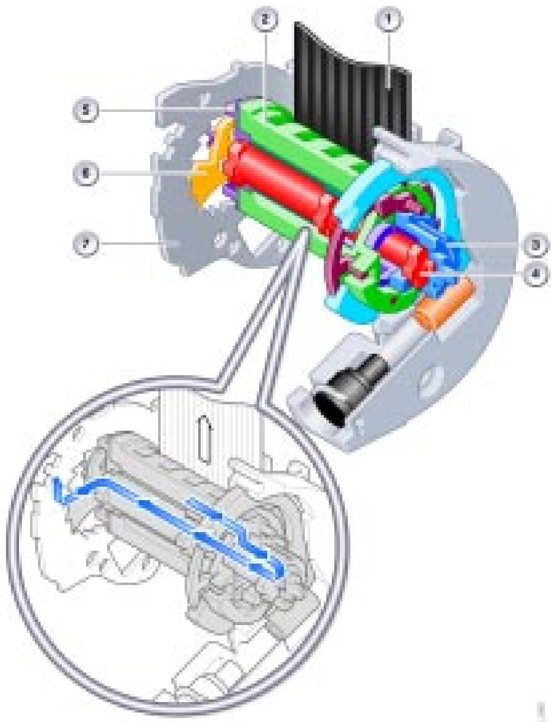
If the seatbelt roller is turned relative to the fixed torsion bar, the force is transferred to the thicker part of the torsion bar. This produces the high power level. This is the function of a normal emergency locking retractor.



Index	Explanation	Index	Explanation
1	Ignition	3	Shaft ring
2	Ratchet ring	4	Locking pawls

In the event of a crash, the gas generator is ignited and a plunger moves out, shifting the shaft ring axially. The locking pawls are now no longer held by the sleeve and no longer transfer more torque to the center head of the torsion bar.

The belt force is now passed across the right-hand head end into the stage shaft and runs through the entire torsion bar. The lower diameter on the right-hand side means that the torsion bar is twisted further and thus the force is reduced to a lower level.



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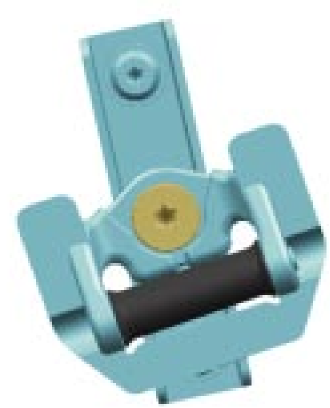
Seatbelt Upper Anchor Position

Using new simulation methods with regard to installation and ergonomics, it was determined that there is an optimal area for all occupants to locate the seatbelt upper anchor.

The anchor point is no longer adjusted automatically based on seat movement as the system on the previous model. In addition the fitting is now designed as a roller. The low friction power (drag) of the seatbelt increases wearing comfort.



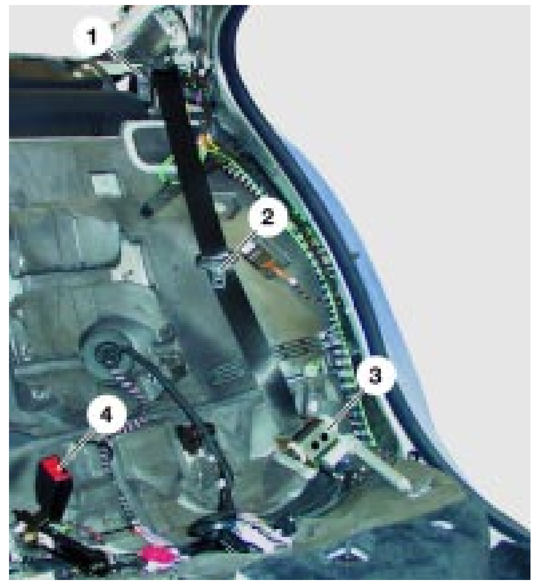
Rear Seatbelt (End Fitting) Tensioner (E65/E66)

If the rear airbag package is ordered, end fitting tensioners are fitted for the outer rear seats. In the middle, a three-point automatic belt is fitted. (The basic version has 3 three-point automatic belts.)

The rear end fitting tensioners have the same task as the seatbelt tensioners at the front, that is removing the slack in the belt during the crash as well as early binding of the occupant to the vehicle deceleration (called riding out the crash).

Since the space available beneath the rear seat is limited, it meant that a component similar to the front seatbelt tensioner could not be used, a new solution had to be found.

The belt slack is removed by drawing in the seat-belt strap at the end fitting point. The inertia reel seatbelt forms the upper attachment point, the end fitting tensioner is the lower attachment point.



Index	Explanation
1	Inertia reel (mechanical)
2	Sliding latch plate
3	Belt (end fitting) tensioner
4	Belt buckle

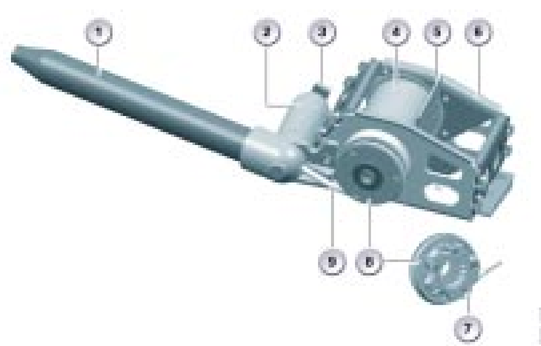
Operation

The rear seat satellite (SSH) ignites the ignition stage in the event of a crash if the seat has been detected as occupied.

When the gas generator ignites, the rise in pressure shifts a plunger in the pipe. The cable end is drawn in the pipe in a linear direction by the plunger. The other cable end is wound by a pulley and turns the belt winding shaft.

A roller coupling blocks the belt winding shaft so that when force is applied into the belt system after the tensioning process this can no longer be turned back. The end fitting tensioners tighten the belt slack at the pelvic area first and then the chest area belt slack.

The tensioning path is determined by the cable pulley diameter and the usable plunger travel. The maximum tensioning length is approx. 150 mm.



Front Seatbelt Tensioners (E6X vehicles)

On the E6X vehicles , pyrotechnic seatbelt tensioners are used for the driver and passenger seat. The principle of the seatbelt lock tensioner is the same as that used in the E38/E39.

The seatbelt tensioner has the task in the event of a crash to remove or reduce any belt slack in the pelvic and shoulder region.

The belt slack comes about mainly due to the motion of the occupants or due to clothing, (especially when heavy clothing are worn in the winter).

This ensures that the occupant is restrained firmly on the seat and prevents "submarining", slipping under a slack seatbelt.

There is also earlier restraint and thus earlier binding to the vehicle. The seatbelt tensioner forms a unit with the seatbelt buckle. It consists of an ignition stage, generator, plunger and cable. The belt buckle switch is integrated in the seatbelt buckle.

In the event of a crash of sufficient severity, the gas generator is ignited. The gas spreads and shifts the plunger in the tensioning pipe. The cable connected to the plunger then pulls the seatbelt buckle downward and the belt slack from the belt system.

For these models, there are the following technical changes. The ignition stage is no longer directly connected onto the gas generator but rather the connection comes out on a cable together with the belt buckle switch cable and is plugged under the seat. If the seatbelt tensioner needs replacing, the seat does not have to be removed.

Seat Belt Buckle Switch

The belt buckle switch used in the E6X models is a two-wire Hall switch, as already in use in various models since 3/97.

The airbags triggering thresholds are different depending on the crash severity and depending on whether the seatbelt has been fastened or not.

The belt buckle switch is located in the seatbelt buckle on the driver and passenger seat. It is used to detect whether the seatbelt has been fastened or not. The detection arrives as a signal at the relevant satellites. The detection serves to trigger the pyrotechnic actuators in the event of a crash,(e.g. seatbelt tensioner, airbags etc.)

The belt buckle switch also serves to initiate a seatbelt warning in case the vehicle is started without a seatbelt having been fastened.

Seat Integrated Belt Systems (SGS)

The SGS system is used on vehicles that do not have a b-pillar post. The first vehicle to use the SGS seat was the E31. Currently, the E46 convertible and the E64 use the SGS seat.

All seat belt attaching points including the upper anchor point are integral to the seat frame. All of the forces in a collision are absorbed by the seat frame and the floorpan.

The SGS seat allows the best possible seat belt geometry in relation to the occupant.

The seat belt is wrapped tightly around the occupant irrespective of seat position and body size. This helps reduce the amount of free seat belt length and also further reduces excessive slack.

The features of the SGS seat are as follows:

- All of the seat belt attachment points are connected to the seat frame.
- The inertia reel clamps the seat belt at the closest possible point to the occupant.
- Optimum protection of occupants in the event of a collision.
- Seat belt strap is released when the backrest is folded or adjusted.
- Comfort is maximized by allowing ideal body restraint for any seat setting or body size.
- Restricted forward displacement of occupant due to additional seat belt strap tensioner.
- More protection during rear and side impact.
- No “submarining” effect.
- Ideal solution for vehicles without b-pillar

Seat Occupancy Detection

In addition to the conventional seat occupancy detection systems, the E65 also utilizes rear occupancy detection.

Seat occupancy detection mats are installed in the seat cushion of the driver and passenger seat and if equipped with optional rear airbags, they are also used in the left and right rear seats.

The sensor mat is identical to the mats used in previous models for the MRS systems. The sensor system consists of pressure sensors that use an electronic evaluation unit (SBE) to detect whether there is weight on the seat.

When a weight (such as a passenger) is added to the seat, the system recognizes the seat as occupied. The electronic evaluation units of the seat occupation mats are connected to the relevant satellites.

(SSFA/SSBF=sensors for front seat, SSH=sensors for rear seat)

The information regarding seat occupation is required for activation of the following functions:

- Airbag activation
- Activation of the seatbelt tensioners and/or end fitting tensioners
- Triggering the active head restraints
- Automatic positioning of the rear head restraints

Principle of Operation

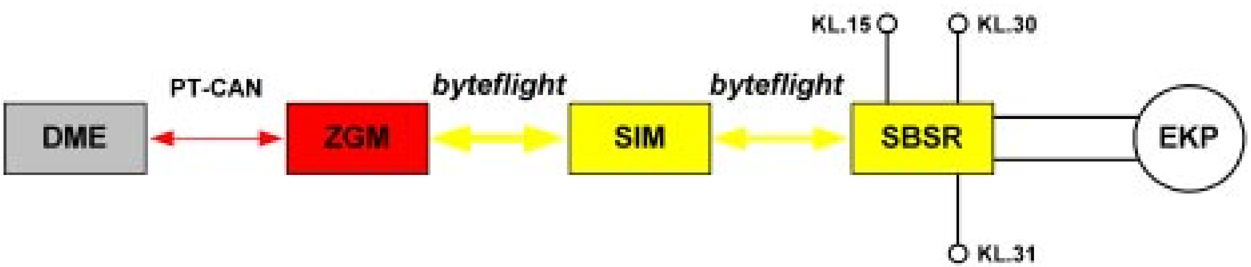
Fuel Pump Cutoff Circuit (E65/E66)

Unique to the E65, is the operation of the fuel pump circuit. Rather than the conventional method of controlling the fuel pump via a DME controlled relay, the fuel pump control circuit is now a function of the SBSR satellite.

The fuel pump is controlled via a PWM signal from the SBSR which allows a variable delivery rate. The variable delivery rate is controlled by a request from the DME which is based based upon engine requirements.

The advantages of having a fuel pump with a variable delivery rate are:

- Reduction of fuel tank warming (reduced evaporative emissions)
- Reduction of power consumption by approximately 50 watts.
- Increase of fuel pump service life.
- Integration of crash deactivation
- Elimination of fuel pump relay



The SBSR contains additional circuitry for the power supply of the fuel pump. The SBSR receives signals via ***byteflight*** for the operation of the fuel pump.

The DME determines the fuel volume requirement in liters per hour. The SBSR receives the fuel requirements from the DME (ECM) via the PT-CAN/***byteflight*** pathway.

The delivery volume the fuel pump is regulated by the EKP controller in the SBSR. The EKP controller supplies the fuel pump with PWM control voltage.

The current consumption (amperage) of the fuel pump is measured by the EKP controller. The amperage reading helps determine the rotational speed of the pump. The rotational speed is transmitted to the microprocessor, which calculates the delivery volume of the pump. The actual delivery volume is compared to a set of pre-determined values. The fuel pump speed in then regulated using these comparisons.

Fuel Cutoff After Collision

If the ISIS system detects a crash of sufficient severity, the fuel pump is shut down to prevent the potential of fire. The fuel pump can be re-activated by switching the ignition off and on.

Emergency Call, US
Starting with the introduction of the E60, the vehicle is capable emergency call functions as well as a breakdown call. The emergency call functions available include the manual emergency call as well as the automatic emergency call in the event of a crash.

Even if no telephone has been ordered, every vehicle has a Telematic Control Unit TCU, a telephone aerial, a hands-free unit. The TCU is now GPS capable with electronics for locating the vehicle.

In order for the E65 to be capable of emergency calls, the vehicle must have the handset installed.

Manual Emergency Call
The emergency call switch is connected directly to the TCU. Pressing the emergency call switch sets up a voice connection with the provider "Cross Country." The voice connection is indicated by a flashing LED in the switch.

Automatic Emergency Call
In the event of a crash with corresponding crash severity, the SIM transmits a crash telegram to the TCU (via the K bus). The Global Positioning System informs the TCU of the location of the vehicle. The TCU places an emergency call, which at the same time contains the location of the vehicle.

A voice connection is set up with the provider "Cross Country" to obtain more information on the accident (severity of the accident, number of injured) so that rescue operations can be initiated.

Breakdown Call
The Breakdown call button is in the Central Information Display. Selection can be activated by means of the controller. If the breakdown call button is activated, a connection to the BMW Emergency Service of the relevant country is set up.

Workshop Exercise - Diagnosis

Using an instructor designated vehicle, perform complete short test on vehicle. Proceed with diagnosis based on complaint listed below. Complete worksheet using proper format regarding, “Complaint/ Cause and Correction”.

Vehicle: ______________ Chassis #: ____________ Production Date: ______________

Complaint:

Cause:

Correction:

Workshop Exercise - Diagnosis

Using an instructor designated vehicle, perform complete short test on vehicle. Proceed with diagnosis based on complaint listed below. Complete worksheet using proper format regarding, "Complaint/ Cause and Correction".

Vehicle: ______________ Chassis #: ____________ Production Date: ______________

Complaint: ____

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Cause:

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Correction:

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Classroom Exercise - Review Questions

1. Which vehicles are currently equipped with knee airbags?

2. On what vehicles is the AKS system used on? And why?

3. When storing an airbag, what side should face up? And why?

4. What is different about the "Advanced HPS" (AITS) as compared to the early HPS systems (E38/E39 etc.)?

5. On the E65/E66 equipped with the rear airbag package, which component is responsible for controlling the rear seat belt tensioning systems?

6. On the E65/E66, describe the exact signal pathway from the DME to the electric fuel pump:

7. What component triggers the BST on the following vehicles?

E65/E66

E60

E63/E64

8. What is a “SMART” airbag?

9. Currently, which vehicles are equipped with battery cable monitoring?

10. On vehicles equipped with battery cable monitoring, which two ***byteflight*** components are responsible for battery cable diagnosis?